PRE-PROGRAMMING: EVALUATION OF WORKSPACE TYPES AND WORKSPACE ALTERNATIVES IN EDUCATIONAL SETTINGS

A Dissertation

by

CARLOS ALEJANDRO NOME

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2008

Major Subject: Architecture

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Approved by:

Chair of Committee,	Robert E. Johnson
Committee Members,	Mark J. Clayton
	Kirk Hamilton
	Benito Flores
Head of Department,	Glen Mills

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ABSTRACT

Pre-programming: Evaluation of Workspace Types and Workspace Alternatives in Educational Settings. (December 2008)

Carlos Alejandro Nome, B.S.; M.Eng., Federal University of Santa Catarina, Brazil

College of Architecture

Chair of Advisory Committee: Dr. Robert E. Johnson

The overall objective of this research was to improve the understanding of worker attitudes and perceptions toward different workspace types and workspace alternatives and how they are related to processes and activities native to a given organization. The specific goals of this study were:

•The development of a methodology to assess workers attitudes toward different workspace alternatives for use in the planning stages of new offices.

•Identification of workspace variables that affect perceptions and preferences regarding the alternatives based on the proposed units of analysis (individual, interpersonal relations, and organizational).

This research consisted of mixed methodology. It was a cross departmental study of needs and preferences of workers regarding key variable and choices of workspace types

and workspace alternatives. The main research instrument was a four stage web based survey. The secondary component was focus groups.

By tracking these declared needs, preferences and choices regarding workspace types and workspace alternatives it was possible to identify if they associate with demographic information, work performance, and the proposed units of analysis, within a given organizational structure. This information provided a substantial knowledge base for decision makers in the planning stage of relocation of people, and the allocation of space processes. This study provided decision makers in the above mentioned processes a tested methodology that enables the development of a proactive approach to innovative workspace planning.

The results are relevant to designers, managers and facility managers as it provides a perspective to understand or identify potential space and layout improvements in existing and future workplaces based on the core activities of any given organization. Such information will allow managers to make informed decisions about future workspace changes, as well as planning new workspace alternatives to continually support the organization’s objectives.

DEDICATION

To my wife, Viviane, for the years of love and support, it was quite a ride!

To my family

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1. INTRODUCTION

1.1. Importance of Workspace Research

In a parallel with optimization of operations in factories, early workspace studies compared office workers to machines. As such, the concept that workers needed to be "well oiled" to perform at their best was widely explored (Oborne & Gruneberg, 1983). This reasoning initiated the quest for ways to increase office worker productivity, and the ongoing pursuit of an ideal office workspace.

Since early explorations of office design concepts, designers and researchers have tried to identify the optimal office. The most known product of this era is the "bürolandschaft" (Zelinsky, 1997), in other terms, the much debated and studied open office. Attempts to define the ideal workspace initially led to the discussion about open versus closed offices and how these solutions affect worker productivity. In the past 30 years, most studies focus on post occupancy evaluations and the understanding of the effects of current workspaces on the workforce. Examples are the works of Weinstein (1976), Marans, Spreckelmeyer et al. (1981), Vischer and Fischer (2005), Kantrowits and Nordhaus (1980), Goodrich (1982), and Wineman (1982). Widely acknowledged as a critical part of the feedback loop for continuous improvements, this approach leaves a gap in the knowledge base required for addressing upcoming changes in the work environment.

This dissertation follows the style of *Environment and Behavior*.

This study originates from concerns related to current reactive practices in the workspace planning and implementation processes of office environments. Specifically, this study intends to address the problems of adequate space allocation to individual workers in light of new technologies, communication trends, market pressure and resulting organizational changes in educational settings.

The purpose of this study is to provide support for decision making related to workspace planning practices for new and existing facilities in educational settings. This study developed and tested a pre-programming methodology to understand worker attitudes and perceptions towards workspace alternatives within a given academic environment based on its core activities and specific work conducted by such organizations.

The study will assess, in the form of a web based survey, twenty-one variables associated with workspace needs and preferences perceptions of office workers. These variables, for methodological structuring and analytical purposes, are initially grouped into interaction, autonomy (Duffy, Laing, Crisp, DEGW London Limited., & Building Research Establishment., 1993), and physical/environmental variables. The survey will also ask participants to make choices considering two distinct levels of workspace. Participants will be asked to choose between four workspace types, as they relate to the general arrangement of the workspace they work in. Also participants will be asked to choose between five workspace alternatives, as these relate to their individual workspace assignments.

The workspace types used in this study, as defined by Laing and Duffy (1993), are:

Cell – highly cellular enclosed or highly individually used open workstations with high screening or partitions.

Club – diverse complex and manipulable range of settings based on a high variety of tasks. Space must be zoned and planned to suit diverse use.

Hive – open ganged (4 or 6 pack), minimal partitions, maximal filing, Imposed simple space standards.

Den – Group space or rooms, medium filing. Complex and continuous spaces, incorporating meeting spaces and workspaces.

Given the possible status connotations or stigma of common workspace alternatives, terminology such as office and cubicle were replaced with less loaded terminology. The workspace alternatives used in this study are:

Individual fully enclosed space – fully enclosed space. Only one individual assigned to the space.

Individual partitioned space – enclosed spaces. Partition heights vary to satisfy privacy needs of users. Only one user assigned per space. Can be configured to support group work.

Assigned shared partitioned space – partially enclosed spaces. Partition heights vary to satisfy privacy needs of users. More than one user assigned to the space (based on work schedules). Can be configured to support group work.

Unassigned shared partitioned space – level of enclosure and partitioning height vary. Configured to support specific tasks. Space assigned to a defined type of user or team. Use determined by need.

Mobile work environment – no specific space assignment. Work can be done remotely or in the office. Paperless, web processes highly supported. Variety of work settings available to support individual needs.

Focus groups are also proposed as means of addressing key theories and assumptions of the study as well as verify or negate findings of the quantitative portion of the study. The units of analysis through which these alternatives will be observed are: Individual, Interpersonal Relations, and Organizational (E. D. Sundstrom & Sundstrom, 1986b).

1.2. Case for Workspace Choice Evaluation

A commonly acknowledged problem in contemporary workspace research findings is the limitations in external validity, due to the potential differences in types of organizations, work categories, and buildings type. Nevertheless, De Croon (2005) indicates that the research on workspace has practical implication for the implementation and development of innovative offices. Authors like Pullen and Bradley (in, De Croon,

Sluiter, Kuijer, & Frings-Dresen, 2005) also suggest the consideration of the effects of workspace in health and performance in office design. This need is reinforced by the findings of authors like Barush and Hind (in, De Croon et al., 2005), that low worker participation in the implementation of innovation has a negative effect on the workers attitude.

Although worker participation and the consideration of workspace research findings are singled out as important in the planning stages of workspaces, current research does not address this. Most workspace related research is limited to the evaluation of one or more elements of existing environments and their effects on workers' performance and on job satisfaction.

Current research approaches allow for a better understanding of the impact that existing workspaces have on their immediate users. However, these studies have not provided understanding about how workers perceive different workspaces than the ones they are currently experiencing. Furthermore, there is no insight as to how different variables and units of analysis affect their perceptions and potential workspace choices. This important but widely overlooked workspace research element is the focus of this study.

There is a fundamental difference between the existing research on workspaces and this study. The difference lies in the fact that existing research evaluates the attitudes and perceptions of workers towards existing environments in the role of individual users of a given facility and workspace; the proposed study intends to evaluate the attitudes and

perceptions of workers towards workspaces that would serve as alternatives to their current workspace, in the role of potential users considering their needs and preferences, asking them to make choices under three distinct units of analysis (individual, interpersonal, and organizational).

Although this study differs from existing studies in terms of intended outcomes, it focuses on the same topic – attitudes and perceptions of workers toward workspaces. This leads to the question: What variables from existing workspace studies could be used in this proposed front end study of workspace alternatives? To answer this question it is necessary to understand the variables that affect the outcomes at each of the desired units of analysis. It is also necessary to understand the viability of collecting attitudinal data on each of the variables and, when necessary, develop or adapt substitute measurements.

1.3. Problem Statement

Organizations are often faced with the need for spatial changes in their facilities. Reasons for this vary from the acquisition of new technology, growth, change in processes, or new educational demands to catastrophic events. Planning the most adequate workspace to support administrative staff in educational settings can prove to be a complex task. What is the most adequate layout? Open or closed offices? Should centralized environmental controls be used? Who sits by the windows? What is the adequate work area and storage? Is there a need for defined workspaces, or even offices? Where, when and how should resources be made available? And what about the next

time there is a need for change? What is the cost over time when comparing one solution to another? Independent of the adopted strategy there will be an impact on workers.

1.4. Purpose and Objectives

The purpose of this study is to provide support for decision making related to workspace planning practices for new and existing facilities in educational settings. This study proposes to develop and test a pre-programming methodology to understand individual attitudes and perceptions towards workspace alternatives within a given educational environment based on its core activities.

The overall objective of this research is to improve the understanding of choices made by individuals with regards to workspace types and alternatives and how they are related to theoretical concepts such as autonomy interaction and varying units of analysis proposed in the workspace literature. This research will approach, from both quantitative and qualitative perspectives, the relationship of such choices, the processes and activities native to a given educational environment.

The study proposes to perform two key tests. First, test the validity of using the units of analysis proposed by Sundstrom and Sundstrom (1986) when assessing workspace alternatives. The units of analysis in consideration are: Individual, Interpersonal Relations, and Organizational (E. D. Sundstrom & Sundstrom, 1986b). Second, to evaluate the proposed association between workspaces and varying levels of autonomy

and interaction, as described by Laing and Duffy (1993) as well as other factors identified in the data analysis process of this study.

The study assesses twenty-one variables associated with workspace needs, current workspace, and preferences of individuals regarding their workspaces. These variables are grouped into interaction, autonomy (Duffy et al., 1993), and physical environmental variables. Participants are also asked to choose between four workspace types and five workspace alternatives, as indicated earlier.

By tracking these declared perceptions regarding workspaces and workspace type as well as workspace alternative choices, it is speculated that it will be possible to verify if and how they are associated. The research also proposes to study associations with demographic information, with combinations of the variables, and proposed units of analysis (individual, interpersonal relations, and organizational) within a given educational structure.

The specific goals of this study are:

- The development of a methodology to assess workers' attitudes and perceptions toward workspaces that could be used as alternatives to their current situation, for use in the planning stages of remodeling of existing facilities and or new facilities.

- Identify, if any, existing relationships between individual's perceptions about commonly used workspace variables, units of analysis (individual, interpersonal relations, and organization) and choices of workspace types and workspace alternatives.

1.5. Research Questions

What is the relationship between stated preferences, needs, and perceptions about workspace in terms of selected variables, within the choices individuals make when opting for workspace types and workspace alternatives at any of the three proposed units of analysis (individual, interpersonal, and organizational)?

1.5.1. Sub-questions

This study proposes to pursue the following sub-questions:

- Are there differences between the choices of workspace types and alternatives made at different units of analysis? Hypothesis: there will be differences in the choices of workspaces made based on the level of analysis considered for each of the choices made.

- Are there variables that influence choices between workspace types and alternatives? Hypothesis: there will be variables that will be associated to the choices made at different levels of analysis.

- Do autonomy and interaction, preferences, needs and perceptions influence the choices between workspace types? Hypothesis: the grouping of interaction and autonomy variables will be associated with the choice of workspace types.

- Do autonomy and interaction, preferences, needs and perceptions influence the choices between workspace alternatives? Hypothesis: the grouping of interaction and autonomy variables will be associated with the choice of workspace alternatives.

In this study the *dependent variables* are the workers' choices between workspace types, choices between workspace alternatives, and the units of analysis (individual, interpersonal relations, and organization). The *independent variables* are stated preferences, needs and perceptions, regarding twenty one selected variables based on the literature review as well as demographic data.

1.6. Original Contribution and Significance

The principal outcome of this research, and original contribution to the field, is a methodology to understand workers' attitudes and perceptions, in a given educational setting, toward workspace alternatives. This approach, by means of a pre-programming assessment, will provide a knowledge base that can be used in the planning processes of remodeling of existing facilities and or new facilities.

This study provides decision makers involved in the above mentioned processes a tested methodology to assist on the development and selection of workspace alternatives. These results will be relevant to designers, facility managers, managers, and researchers as it will provide a perspective to understand and identify relevant substitute workspaces. Ultimately, results would allow the development of new strategies for existing and future workspaces based on workers attitudes and perceptions of workspaces in given educational environments.

1.7. Outline

This outline describes to the reader the contents of each section of this dissertation.

The first section was an introduction to the research topic. In this section readers had a broad overview of the research problem, a succinct statement of the research objectives goals and questions. Section one ended with the presentation of the original contribution and significance of the present study to the field of architecture.

Section 2 consists of the literature review. This section starts with an overview of the history of workspace studies followed by a discussion on contemporary workspace research. Key contemporary workspace research topics and an overview of the range of workspace research are presented. A discussion on work performance, attitude assessment, and architectural programming follows. The section ends in a review of workspace research methodologies and a discussion about their relevancy to the proposed study.

Section 3 consists of the proposed methodology and its justification. The section introduces the research design and key theories and assumptions guiding the study. The two main methods used in this research are presented. Data collection, data analysis, and pretest of research instruments for the survey and focus groups are discussed as well. The section concludes with a statement of limitations and implications institutional review board rules.

Section 4 presents the results of the survey to the readers. An overview of the survey procedure is presented. Results are structured in terms of response demographics; current workspaces; choice of workspace types; choice of workspace alternatives; needs, preferences and current situation data reduction; and finally computation and analysis of scores.

Section 5 presents the findings of the focus groups conducted for this study. This section starts by introducing the general focus group objectives and sampling strategy followed. Results of the focus groups are presented in terms of preferences and needs; units of analysis; interaction; autonomy; and productivity. Results are followed by a discussion on the topics addressed and focus group conclusions.

Section 6, is the final section of the dissertation, and it consists of the summary of findings and conclusions of the study. The summary portion of this section is presented in terms of units of analysis; factor analysis; needs and preferences; factors and variables influencing workspace choices and is finalized by a subsection on performance and

productivity. Conclusions of the study start with a discussion of the results followed by model critique and development. Contributions, originality, generalizability and limitations of the study are presented and discussed. The dissertation ends with a discussion about future research on the topic of workspace choices.

2. LITERATURE REVIEW

Literature shows that current workspace research approaches allow for decision makers to understand the impact that existing workspaces have on their immediate users. However these studies have not provided understanding about how workers perceive different workspace alternatives and how different variables and units of analysis affect their choices with regards to such alternatives. A survey of workspace methodologies is presented and their relevancy to the scope of this study discussed.

2.1. Origins of Workspace Studies

At its first stages, approaches to workspace studies presupposed a mechanistic relationship between workers and their environments (Duffy, 1974b). Workspace research in the early 1900s assumed that the environment exerted a uniform influence on people, and that each variable could be studied in isolation. These studies were mainly conducted in industrial settings, where the main driver was the concept of productivity (Oborne & Gruneberg, 1983). Workers were seen as part of a machine that needed to be "oiled" to function at its best (ibid.). Key theories and concepts that contextualize these approaches are: the introduction of Taylor's Scientific method (Taylor, 1911); Behaviorism ,and Fordism (Duffy et al., 1993; Statt, 2004).

Mechanistic approaches to studying the effects that the environment had on workers were deeply affected by the Hawthorne studies (Landsberger, 1958). As a result of this study, initiated in 1924, the interrelated nature of factors influencing workers

performance and satisfaction was brought to the attention of the scientific community. Following this development, researchers began to incorporate in their studies factors such as workers' attitudes and interpersonal relationships (Duffy, 1974a; E. D. Sundstrom & Sundstrom, 1986b). In the early 1950s Systems (Bertalanffy, 1969) was introduced as a new way to explain the relationship between the variables that were, as of that point in time, perceived to simultaneously affect organizations.

The beginning of human factor and ergonomics (Wilson & Corlett, 2005) studies paralleled the introduction of Systems Theory in workspace research. Based on human factors, the relationship between man and work environments was perceived by researchers as an interactive model, a continuous feedback loop between the two. A wide range of research with practical focus was conducted from human factors and ergonomic perspectives. Most of the research on human factors and ergonomics was concentrated on the individual interaction with its immediate environment (E. D. Sundstrom & Sundstrom, 1986b). Also, Sundstrom states the few examples of research regarding interpersonal relations emerged only in the late 70s early 80's (1986b).

Environmental psychology emerged between the late 1950's (White, 1979) early 1960's (E. Sundstrom, Bell, Busby, & Asmus, 1996). Mainly, it focused on the understanding of "human behavior and experience and the physical environment" through a problem-centered approach (White, 1979). Researchers in environmental psychology explicitly recognized that the physical environment had social, psychological and cultural components (White, 1979). It was based on this development that for the first time

multiple levels of analysis were recognized as important for the study of the physical environment (E. Sundstrom et al., 1996; White, 1979).

2.2. Contemporary Workspace Research

Contemporary approaches to research regarding office workspace started in the early 1970s, and at the time emphasis was placed on the user perspective (Arge, 2005; Lindahl, 2004). Through a review of recent workspace literature it became evident that research on workspace in the past thirty years tended towards the use of Post Occupancy Evaluations (POE). Typically POE's are studies that examine how effective occupied, designed environments are for their users (C. M. Zimring & Reizenstein, 1980).

Methods and techniques vary from one study to another (C. M. Zimring & Reizenstein, 1980). Nevertheless, these studies fall within the scope of environmental psychology, in addition to environment and behavior research. Such contributions have been critical to advances in the understanding of workspaces and advance to the current state of knowledge in this critical field. The contributions of leading contemporary authors in the field are discussed bellow.

2.2.1. Work Patterns and Workspaces

In *New Environments for Working* Laing and Duffy (1998) studied the effect that contemporary working patterns have in workspaces. The authors name this effect the "hierarchy of building user relationships" (Duffy et al., 1993). This study was based in the development and testing of models that incorporated contemporary working

practices through case studies. The models proposed were based on three core variables: Work Patterns, HVAC Systems, and Building Types (Laing & Duffy, 1998). Each of the variables was subdivided into four generic categories to evaluate different relationships.

The authors were able to identify affinities between each combination of variables as well as overall affinities across the three core variables. As a final result, Laing and Duffy offer directions for products and implications for workspace design.

The occupant survey in *New Environments for Working* (Laing & Duffy, 1998) focused on five major elements: environmental comfort, noise, control over environmental systems, furniture, and general environmental issues. No environmental measurements were conducted.

2.2.2. Organizational Ecology

Based on the results of multiple workspace case studies Becker and Steele introduced the concept of Organizational Ecology (Becker & Steele, 1995). This concept unifies physical settings and social settings of organizations based on core processes over time. In order to accomplish this, it relied on disciplines such as: human resources, organizational development, human factors, architecture and engineering, industrial engineering and organizational behavior.

The authors postulate that a high-performance workspace is a critical element to support the core functions of different organizations (Becker & Steele, 1995). For Becker and

Steele, the workspace should be a function of management philosophy. Ultimately the workspace should be a tool to transform corporate philosophy into corporate practice. Workspace was viewed as a single integrated system based on how an organization chooses to convene their employees in space and time.

A critical element in their writing is the proposition of the use of five dimensions of organizational health (sense of identity, reality testing, task accomplishment, problem solving, and adaptability and energy flow) as the criteria to evaluate and inform spatial decisions instead of the economic bottom line (Becker & Steele, 1995).

2.2.3. Satisfaction and Performance

Michael Brill's work is based on environmental design research principles. His research on workspace focuses on the use of four bottom-line measures to support workspace related decision making processes (Brill, Margulis, & Konar, 1984 a). Although Brill recognizes other criteria used by organizations in the decision making process he makes the case for using "measurable and reasonably quantifiable" criteria. The four main measures for the author's studies are: environmental satisfaction, job satisfaction, job performance, and supervisor/job performance. Brill also used as a parameter what he referred to as a "quasi bottom-line measure": ease of communications.

Brill's main concern was to provide useful results to be applied in planning and management of workspaces, more so than establishing design directives. Eighteen variables were studied and their relationship to the bottom-line measures tested through

long self administered questionnaires (Brill et al., 1984 a; Brill, Margulis, & Konar, 1984 b). Questions were designed to elicit descriptive objective information about the environment and behavior. Job performance was measured through self and supervisor assessment.

2.2.4. Human Behavior and Post Occupancy Evaluations

In “Evaluating Built Environments” Marans and Spreckelmeyer (1981) approached their research from a human behavior perspective. In their study of a federal building they developed self administered questionnaires that collected subjective data from users, visitors and local residents. Also, the researchers collected objective data on the physical environments through field measurements and existing drawings. The objective was to create a systematic approach to POE that would enable the researchers to make inferences about workspace quality.

The research was based on a conceptual model which suggested that workspace satisfaction was dependent on individual evaluation of a number of attributes of a given environment. The model also recognized that these evaluations were dependent on the individual’s previous experiences (also defined by the authors as standards) and perceptions. In turn, these perceptions were viewed as affected by an individual’s characteristics. In this study four factors were identified as defining workspace satisfaction: position or job type, organizational context, perceptions of physical attributes, and measurable attributes.

Although question fifteen in Marans' questionnaire (Marans et al., 1981) addressed the issue of workspace preferences given five alternatives, no findings were reported in this matter.

2.2.5. Units of Analysis and Outcomes

Sundstrom and Sundstrom proposed the existence of three units of analysis that affect users' perceptions of workspaces (E. D. Sundstrom & Sundstrom, 1986b). Their framework was based on the premises that "people and their physical environments exert mutual influence"; and that "relationships between people and physical settings differ, depending on whether the unit of analysis is the individual, the interpersonal relations or the entire organization."

Each unit of analysis was defined in the basis of the outcomes they emphasized. The use of multiple research strategies was advocated on a case by case basis, as well as use of comprehensive studies. The authors reviewed the theories and methods behind workspace studies at the three proposed units of analysis. Although Sundstrom and Sundstrom define variables influencing workspace perceptions there are no specific instruments or methods suggested for conducting workspace.

2.2.6. Functional and Technical Performance

Davis and Szigeti's studies on buildings and work environments culminated in the development of the current American Society for Testing and Materials (ASTM) serviceability standards. For the development of the ASTM standards the authors

emphasized the need to differentiate functional performance, from technical performance (Davis, Ventre, ASTM Committee E-6 on Performance of Building Constructions., & ASTM Subcommittee E06.25 on Whole Buildings and Facilities., 1990). As defined by the authors, functional performance focuses on the user perspective, while technical performance focuses on criteria for specifications, testing and measuring. Their studies were guided by an action research approach with the stated intent to "bridge the gap from theory to practice" (Davis & Szigeti, 1997). In the portion to the Serviceability Tools and Methods (ST&M) that deals with workspace satisfaction, the users' perceptions of space were emphasized (Szigeti & Davis, 2001).

The authors' perspective presented architectural programming and facilities management as the ultimate beneficiaries of the workspace satisfaction surveys. Their approach to occupants' group and individual effectiveness used seventy-nine scales divided into fourteen variable categories.

2.2.7. Action Research and Post Occupancy Evaluations

Jacqueline Vischer's approach to workspace studies is based on action research. Vischer developed the Buildings In Use method (BIU) that consists of self administered questionnaires applied to workers on a given building (J. Vischer, 1996). The questionnaire focuses on key elements that indicate the environmental quality based in the notion of "a building as a changing system of interdependent physical features and human activity" (J. C. Vischer & Fischer, 2005). No physical attributes measurements are collected.

The argument for this approach is that “human judgment alone can provide a useful measure of building environments” (J. Vischer, 1996). The basis for this argument comes from the inconsistency of attempts to validate attitudinal judgments by instrument measurements or known adopted standards. The notion of workspaces as dynamic systems is introduced also to question the application of solely analytic techniques to define environmental quality (J. C. Vischer & Fischer, 2005).

2.2.8. Total Building’s Performance

Bordass and Leaman’s action-based research falls into a category of comprehensive studies that goes beyond the scope of workspace studies alone. Their studies encompass multiple aspects of the built environment to assess building performance, integrating quantitative and qualitative methodologies. Their research project, named Probe for Post-occupancy Review Of Buildings and their Engineering (B. Bordass, Cohen, Standeven, & Leaman, 2001 a; B. Bordass, Cohen, Standeven, & Leaman, 2001 b; B. Bordass, Leaman, & Ruyssevelt, 2001c; R. Cohen, Standeven, Bordass, & Leaman, 2001; Leaman & Bordass, 2001), focused on all aspects of building use and operation.

Within the multiple elements of their studies user satisfaction is approached in the form of Building Use Studies (BUS) (Leaman & Bordass, 2001). Their research on workspace satisfaction identified 43 variables divided into two main categories: user satisfaction and user control. The authors recognized buildings as complex total systems. The variables mentioned in the authors’ articles remain unpublished due to proprietary issues.

2.2.9. Range of Research on Workspace

Under the principles of contemporary environment and behavior research, workspace studies have dealt with a great number of subjects.

Approaches to overall evaluations of the built environment, such as the use of a behavioral approach (Marans et al., 1981; J. C. Vischer & Fischer, 2005; Weinstein, 1976), and post occupancy evaluations studies (Goodrich, 1982; Kantrowitz & Nordhaus, 1980; Marans & Spreckelmeyer, 1982; Wineman, 1982) have been conducted in a variety of organizational settings.

Comparison studies such as the one conducted by Brennan, Chugh et al. (2002) dealt with the environmental differences between traditional and open offices and the resulting implication of these differences. Similar studies on open versus closed offices have been conducted from a behavioral perspective (Marans & Spreckelmeyer, 1982). Authors like Horgen and Price (Horgen, 1999; Price, 2002) developed studies about current trends in office design and their effects on work relations and corporate culture.

The overall effect that workspace research has on design decisions was also observed through the perspective of programming and space planning (Davis & Szigeti, 1982; Kelly, Hunter, Shen, & Yu, 2005). Critical research has been done to assess the impact workspace has on worker productivity (Brill et al., 1984 a), satisfaction (Eric Sundstrom, Herbert, & Brown, 1982a; E. T. Sundstrom, Jerri P.; Brown, David W.; Forman, Andrew; Mcgee, Craig 1982) and health (De Croon et al., 2005).

Research conducted on workspaces varies from environmental comfort factors (J. Vischer, 1989) such as ventilation, thermal comfort, noise and lighting to psychological factors (Statt, 2004), spatial cognition (Wollman, Kelly, & Bordens, 1994; C. Zimring & Dalton, 2003), way finding, and behavior (Bechtel & Tsertsman, 2002; Wineman, 1986). Zalesny also conducted studies on the perception and attitudes of workers toward work environments and organizational levels (Zalesny, Farace, & Kurchnerhawkins, 1985).

Researchers have also studied the effects of organizational change in office workers (Spreckelmeyer, 1993). In the past ten years a common motivation for such research is the assessment of how workspace affects work productivity and organization efficiency (A. L. B. Bordass, 1999).

2.3. Performance and Work

Performance deals with the accomplishment of a specified task, activity or goal. This concept, in terms of individual work, is deeply related to origins of workspace studies, when in industrial settings workers were viewed as machines in terms having a direct impact on industrial productivity (Oborne & Gruneberg, 1983). This perception evolved from Taylor's Scientific method; Behaviorism, and Fordism (Duffy et al., 1993; Statt, 2004). Contemporary approaches to the understanding of worker organizational performance have evolved greatly, and now span both blue and white collar workers and their organizations. Worker and organizational performance today is studied under the scope of industrial and organizational psychology, as well as environmental psychology (Bell, 2001; Brebner, 1982; Siegel & Lane, 1987; Wilson & Corlett, 2005).

Work performance can be associated with skill level, motivation, satisfaction, level of supervision, training, development, compensation, recognition, safety, health, social context, personality, physical aptitude, change, and physical environment (Siegel & Lane, 1987; Statt, 2004; Wilson & Corlett, 2005). In fact, under what is called Threshold Trait Analysis (TTA) 33 traits are listed, in 21 job functions and five major areas, that directly impact job performance (Siegel & Lane, 1987).

Given the number and complexity of the elements that impact work performance, measurement of work performance is a naturally controversial topic. No single approach is unanimous and they are dependent on methods and theoretical models, if any, adopted by researchers and organizations (Siegel & Lane, 1987; Wilson & Corlett, 2005). Organizational performance follows the same lines, and is even more complex as specific goals and performance indicators depend on management strategies as well long and short term goals.

2.3.1. Environment and Performance of Work

The impact the built physical environment has on work is one of the many variables of interest when addressing work performance. As with work performance itself the number of variables (Table 2.1.), relationships to other work performance variables, and theoretical perspectives on the subject vary greatly as well.

Table 2.1
Performance Variables Adopted by Multiple Authors

Unit of Analysis	Variables
Individual	Support for office work Thermal comfort Controls and controllability Air quality Ventilation Storage Visual privacy Conversational privacy Noise Floor space Work space Wayfinding Information technology Spatial comfort
Interpersonal	Differentiation Seating arrangements Furniture Inter-workspace proximity Enclosure of workspaces Gathering places Visual privacy Conversational privacy Information technology Office noise control Building noise control Management perceptions
Organization	Separation of work units Differentiation of work units Information technology Management perceptions

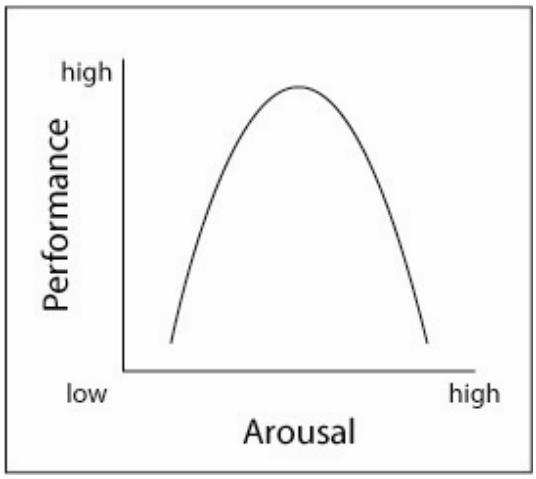
Source: Sundstrom and Sundstrom (1986), Vischer and Fischer (2005), Marans Spreckelmeyer et al (1981), Davis and Szigeti (1997), Leaman and Bordass (2001).

One example of this complexity is that management in organizations have often looked into the impact that job satisfaction has on work performance (Bruce & Blackburn, 1992) and, as part of such studies, the role the physical environment has on job satisfaction (Bell, 2001). As a result of a review of relevant literature, Sundstrom and Sundstrom (1986b) reported that although the built environment is ranked low in regard to other variables that apply to job satisfaction, workers reported that it has a great impact on their job performance. Meanwhile Herzberg (1966) poses that adequate

"working conditions" do not substantially improve satisfaction, however, poor working conditions lead to dissatisfaction. Herzberg also lists working conditions among other "factors that describe his (worker) relationship to the context or environment in which he does his job" as hygiene factors. In other words, working conditions are considered within factors that need constant and active preventive measures. And again, the satisfier and dissatisfier theory is supported and contested by different workspace researchers and theorists (Brill et al., 1984 a; E. Sundstrom et al., 1996).

Other well accepted theories, such as the arousal theory and overload theory, indicate a more active role of the built environment on performance. The 1908 dancing mice experiments performed by Robert M. Yerkes and John D. Dodson studied the relation between strength of stimuli and rate of learning. The results of this study indicated that performance is a factor of task complexity and external stimuli received, and that at extreme low and high stimuli levels performance will be low (Yerkes, 1908). In the arousal theory, based on Yerkes-Dodson law (Figure 2.1), performance has an inverted "u" relationship to arousal (Oborne & Gruneberg, 1983). The work environment, as a potential source of stimulus, is seen as having more or less impact on performance depending on the complexity of the tasks, which is also consistent with the Yerkes-Dodson law (E. D. Sundstrom & Sundstrom, 1986b).

Figure 2.1
Arousal and Performance Yerkes-Dodson Law Adapted from Oborne and Gruneberg (1983)



In the stimulus overload theory, it is posited that a human's information processing capacity can be surpassed, and after reaching this limit decisions can take a long time (S. Cohen, 1978). According to this perspective, the environment can be seen as a source of distraction, diverting attention from tasks, thus affecting performance. Environmental overload qualities were described as being attentional, informational, psychological and underloading stresses (Brebner, 1982). Similarly to the arousal proposition, the effect of stimulus overload on performance is dependent on task complexity, and it is added to the element of worker ability to cope. Responses to distractions will range from filtering and queuing to error and escape. The element of adaptation is introduced as a behavioral and perception response to the impact of the built environment on individual workers' performance (E. D. Sundstrom & Sundstrom, 1986b).

Another key author when discussing performance and built environment is Michael Brill. His research on workspace focused on the use of four bottom-line measures to support the concept of offices as tools (Brill et al., 1984 a). Brill made the case for using environmental satisfaction, job satisfaction, job performance and supervisor/job performance, and ease of communications as key measures. The results of his studies supported the existence of a positive relationship between physical environment and job satisfaction in nine out of eighteen facets and only two out of eighteen regarding job performance. These two were enclosure and layout.

2.3.2. Work Performance in the Current Study

From the literature, it is clear the complexity of work performance as a topic and in relationship to the existing built environment. The relationship between the built environment and work performance is not clear through existing research and it could be argued that it is a weak one. This is arguably due to the satisfier dissastisfier effect posed by Herzberg and the more accepted relation between job satisfaction and environmental satisfaction.

In the cognitive exercise of evaluating workspace alternatives, rather than existing environments, the satisfier dissatisfier theory does not immediately translate. This theory is dependent in the concept of adaptability, in physical and behavioral terms. However, this element is not present in the evaluation of workspace alternatives, as it is a condition of physical presence or participation in existing physical environment/event.

It is here argued that when faced with workspace alternatives workers will be more inclined to critically evaluate its potential impact on their performance. One factor that will contribute to critical evaluation of their performance in the proposed alternatives will be the awareness level with the subject. Key variables that impact the perception of work environments were selected for use in the evaluation part of the survey. It is believed that this will raise the awareness level of participants regarding the potential impact of such alternatives on their work performance. There is a potential for this type of research to yield different results than ones found through post occupancy evaluations.

As a cautionary measure, since the results of the study might or might not support the argument above, it would probably be safer to add job satisfaction as a component of the research. The incorporation of this element has the potential to increase the perception of value of the study to participating organizations.

2.4. Attitude and Attitude Assessments

The concept of individual attitude can be seen as an individual's tendency to react in a certain manner when confronted by a certain situation or object (Oppenheim, 1966). In contemporary approaches this concept evolves to the acknowledgement of three mutually associated components of attitudes: affective responses, cognitive information, and behavioral information (Haddock, Maio, & Psychology., 2004). Attitudes are considered a theoretical component of all behavior (Krebs & Schmidt, 1993; Oppenheim, 1966; Remmers, 1954), and associated with concepts such as: interest,

appreciations, motives, prejudices, fears, sentiments, loyalties, ideologies character, values, among others (Remmers, 1954).

Assumptions about attitude concentrate in three basic aspects: content, structure and function. Content refers to the degree that individual beliefs affect attitudes, or to the degree beliefs, feeling, and past behavior affect attitudes (Haddock et al., 2004). Structure refers to the strength and value (positive or negative) of attitudes (Haddock et al., 2004; Remmers, 1954). Finally, function refers to why individuals evaluate an attitude object (Haddock et al., 2004).

Considering the broad definition of attitude, assessments of this concept can be applied to almost anything (Haddock et al., 2004), as they are subjective individual impressions of attitude objects (people, behaviors, social issues, etc.). Attitude assessments are commonly used in social, psychological, and environment and behavior studies. Measurement of attitudes can be done through reports, surveys, interviews, logs, journals, and diaries in written or varying forms of audio recordings (Henerson, Morris, Fitz-Gibbon, & University of California Los Angeles. Center for the Study of Evaluation., 1987).

2.4.1. Biases and Limitations

Attitude measurements have inherent problems tied to the concept itself and its related theories. These measurements rely on participants' constructions of the world, subjective in nature. Therefore it is a natural limitation that answers are subject to respondents'

previous experiences, social context, personalities, and beliefs. Also it is assumed that respondents are knowledgeable or have interest in the attitude object to be able to provide valid measurements of their attitudes. Other effects that can lead to bias in attitude measure are peer group pressures, social desirability, ambivalence, inconsistency, and lack of self awareness (Henerson et al., 1987).

Measuring attitudes through self report surveys bring other potential sources of bias and error, that are inherent to the processes of comprehension, retrieval, judgment, response selection and response reporting (Podsakoff, MacKenzie, Jeong-Yeon, & Podsakoff, 2003). Podsakoff and MacKenzie (2003) divide the potential sources of common methods biases in four main categories:

- Common rater effects: related to the impact of using same respondents;
- Item characteristics effects: related to the manner in which items are presented;
- Item context effects: related to the context of items in the questionnaire;
- Measurement context effects: related to the context in which measurement are taken.

Under common rater effects, the authors list as potential sources of bias: consistency motif, implicit theories, social desirability, leniency, acquiescence, mood state, and transient mood state. Under item characteristics effects they list: item social desirability,

item demand characteristics, item ambiguity, common scale formats, common scale anchors, as well as positive and negative item wording. Regarding item context effects sources of bias are: item priming effect, item embeddedness, context-induced mood, scale length and intermixing of constructs. Finally, on measurement context the authors list: predictor and criterion variables measured at the same point in time, location and with the same medium. A summary of definitions is in table 2.2.

The biases reported are present in varying degrees in different research depending on topics addressed and choice of data collection tactics. Literature suggests that these issues should be addressed by researchers to increase validity and reliability of research and instruments. The impact of these biases on research results can be reduced by assessing its potential sources and using appropriate procedural and statistical methods of control (Podsakoff et al., 2003).

2.5. Architectural Programming

Architectural programming is recognized in the architecture industry as a critical pre-design phase. In workspace planning this is the interface where organizations, users and designers would apply methods, techniques and strategies to achieve optimal workspace solutions. Such methods, techniques and strategies vary greatly from author to author. The most well known are the ones described by Becker and Steele (1995), Duffy and Hannay (1992), Duffy and Laing (1993), Allcorn (2003) Marmot and Eley (2000), and Becker (1982).

Table 2.2
Potential Causes of Bias in Common Methods, Adapted from Podsakoff and Mackenzie (2003)

Category	Potential bias cause	Refers to…
Common rater effects	Consistency motif	Tendency to try maintain consistency in responses
	Implicit theories	Respondent beliefs about relationships between variables
	Social desirability	Tendency to behave on a culturally acceptable and appropriate manner
	Leniency	Tendency to give higher rating to someone the respondent likes
	Acquiescence	Tendency to sequentially agree or disagree with questions independent of content
	Mood state	Individual propensity to have positive or negative worldviews
	Transient mood state	Influence of recent event on respondent mood
Item characteristics effects	Item social desirability	How items reflect more or less social desirability
	Item demand characteristics	Cues as to how to respond (related to item social desirability)
	Item ambiguity	Random or heuristic responses to complex or ambiguous constructs
	Common scale format	Influence of scale in the simplification of cognitive processing
	Common scale anchors	How wording of scales influence cognitive processing
	Positive and negative item wording	Potential of positive or negative wording creating artifactual relationships
Item context effects	Item priming effects	Increased salience of attitude objects due to order of questions
	Item embeddedness	Tendency of neutral items embedded in a context (positive or negative) of other items to be perceived the same as its context
	Context induced mood	Potential of the wording of initial questions to set the mood for the response of the entire questionnaire
	Scale length	The effect that the length of scales have on recollection of previous answers when responding to other items
	Intermixing of constructs	Possibility that the use of similar construct will affect inter and intra-construct correlations
Measurement context effects	Measurements a the same point in time	Possibility of artifactual covariance between constructs that are measured at the same point I time (related to item demand characteristics, and implicit theories)
	Measurements in the same location	Possibility of artifactual covariance between construct that are measured at the same location (related to item demand characteristics, and implicit theories)
	Measurements using the same medium	Possibility of artifactual covariance between construct that are measured using the same medium

Two key authors defined the contemporary architectural programming field, William Peña and Henry Sanoff. Sanoff (1977) defines programming as follows: “A program is a communicable statement of intent. It is a prescription for a desired set of events influenced by local constraints, and it states a set of desired conditions and methods for achieving those conditions.”

In contrast Peña in his work with Steven Parshall stays true to the Webster definition (Peña & Parshall, 2001). “A process leading to the statement of an architectural problem and the requirements to be met in offering a solution.” Peña argues that “programming is best as a systematic search for information.”

In common both authors use the concept of needs as the guiding principle for the definition of a program’s requirements. Yet, both authors also clearly distinguish the roles that the concept of needs and the concepts of preferences play in the programming process.

In Peña and Parshall’s five step “problem seeking” method, determination of a client’s functional needs has a direct effect on space requirements. The authors make a point of emphasizing the distinction between “needs and wants” (Peña & Parshall, 2001). The importance of this distinction comes from cost control concerns embedded in their methodology. The authors argue that client cannot always afford what they want, thus the definition of performance, functional and human requirements.

Sanoff also argues for the recognition and understanding of client and user needs in the development of the goals of architectural programs. Guided by a four step process, user participation is incorporated through various techniques that ultimately lead to the statement of needs. Sanoff's approach to programming contrasts with the problem seeking method in that the author advocates for different program types based on varying degrees of user participation. User preferences are incorporated in this programming process as part of various information retrieval techniques, as a means of maximizing the utilization of user expertise.

2.6. Methods Review: Quantitative vs. Qualitative

The array of possible methods and techniques used in environment and behavior research mainly fall within two paradigms: quantitative and qualitative research. Lincoln and Guba, compare quantitative (positivist) and qualitative (naturalist) research based on five axioms: the nature of reality; the relationship between knower and known; the possibility of generalization; the possibility of causal linkages; and the role of values (1985). See Table 2.3. These axioms deal with key assumptions and inherent strength and weaknesses of each paradigm a researcher has to acknowledge when deciding how to conduct its own research.

Table 2.3
Contrasting Positivist and Naturalist Axioms (Lincoln & Guba, 1985)

Axioms About	Positivist Paradigm	Naturalist Paradigm
The nature of reality	Reality is single, tangible, and fragmentable.	Realities are multiple, constructed, and holistic.
The relationship between knower and known	Knower and known are independent, a dualism.	Knower and known are interactive, inseparable.
The possibility of generalization	Time- and context-free generalizations (nomothetic statements) are possible.	Only time- and context bound working hypothesis (idiographic statements) are possible.
The possibility of causal linkages	There are real causes, temporally precedent to or simultaneous with their effects.	All entities are in a state of mutual simultaneous shaping, so that it is impossible to distinguish causes from effects.
The role of values	Inquiry is value-free.	Inquiry is value-bound.

The use of mixed methods implies the integration of quantitative and qualitative research methods (Bryman, 2004). It also is an attempt to bridge the gaps left by the use of any one independent method or technique to resolve a research problem (Singleton, 1988). The criticism against the use of mixed methods comes from the perception that methods and techniques are fundamentally associated with specific paradigms and their axioms. Despite criticism mixed methods approaches have gained recognition in diverse fields (Creswell, 2003) as a form of verifying the results achieved through the use of a single method (Bryman, 2004; Singleton, 1988).

Creswell (2003) advocates that mixed methods vary according to its implementation, priority, integration, and theoretical perspective. The author also proposes the existence of six main mixed method strategies: sequential explanatory, sequential exploratory, sequential transformative, concurrent triangulation, concurrent nested, and concurrent transformative. Other categorizations are proposed by different authors; however they

acknowledge that triangulation is the most commonly applied mixed method strategy (Bryman, 2004; Singleton, 1988).

2.6.1. Methods and Techniques

The following are examples of methods and techniques used in environment and behavior research. Their relevancy to the current study and intended audiences are discussed in the last section of this dissertation.

2.6.1.3. Case Studies

This research method, commonly associated with qualitative research, is widely used in psychology, medicine, law, business and management fields (Miller, Miller, & Salkind, 2002). It is viewed as a research method and as a teaching tool (Yin, 2003a). The main purposes of this method are description, exploration, and explanation (Babbie, 1998, 2008). It is best suited for inquiries regarding contemporary events that are intrinsically related to its context (Yin, 2003b). Case studies can consist of single or multiple cases depending on specific research objectives and can use single or multiple data collection techniques. Most commonly in depth interviews are the main source of information. Other common data collection methods used in case studies are direct observation, participant observation, archival records analysis, study of physical artifacts and documentation (Yin, 2003b).

Strengths of this method lie in its ability to capture a research phenomenon within its context (Yin, 2003b) and its flexibility to adapt to different research intentions (Babbie,

1998). Case studies typically rely on multiple data sources to support its findings, which in turn increases its reliability (Yin, 2003b).

The case study method's major weaknesses are its limited generalizability and, arguably, reliability. Babbie (2008) makes the case for the impact of researchers' world views and personal biases on the findings of this method. In case studies generalizability is only achieved after theories developed based on analytical efforts are tested and replicated (Yin, 2003b).

2.6.1.4. Ethnographical Studies

This method, qualitative in nature, consists of the immersion of the researcher for an extended period of time in the social environment under study (Bryman, 2004). The main purpose of this research method is the critical description of a given cultural/social setting (Miller et al., 2002). The main source of data and information to ethnographers is behavioral observations, although interviews and documentation are also used (Lee, 2000). Types of observation vary according to: the disclosure of the researcher's role; the level of involvement of the researcher; the existence or not of a structure for the observation; and with the object of the observations (Bailey, 2007). See Table 2.4.

Table 2.4
Factors that Define Observation Types, Summary from Literature

Disclosure	Level of involvement	Object of observation	Observation definition
Overt Covert	Full participant Participant as observer Observer as participant Full observer	Spaces Objects Actors Act Event Time Goals Feelings	Structured Unstructured

This research method has the same strengths regarding contextualization of the study and flexibility as case studies. Historically this method is well accepted and widely employed in the anthropology and sociology fields (Miller et al., 2002). By not claiming attempts to generalize its findings ethnography also escapes from this typical weakness of qualitative research (Bryman, 2004).

The main weakness of this type of research comes from the research length uncertainties inherent in the condition of reaching "theoretical saturation" (Bryman, 2004) for the study to be complete. Another weakness comes from the risks associated with the level of involvement and disclosure of the researcher's status (Bryman, 2004).

2.6.1.5. Action/Applied Research

Action/applied research is oriented toward the achievement of specific goals by means of specific actions with the involvement of the affected study group (Whyte, 1991). Methods and techniques adopted vary according to the problem being addressed (Herr & Anderson, 2005). It is participatory in nature, and adaptive to changing needs of

community or organization under study (Miller et al., 2002). This type of research also intends to be cyclical and self sustaining even after the end of a given research project (Herr & Anderson, 2005; Whyte, 1991). It is acknowledged that this method prioritizes relevance over precision.

The strength of this method comes from the visibility of the results when successful. By conducting research that addresses “real life problems” results of such studies are readily applicable to situations that typically require immediate responses (Kayrooz & Trevitt, 2005).

Common problems are poor reliability and validity as well as lack of defined results. Critics also point to potential undesired results due to poor group dynamics or discrepancies in perceptions between researchers and participants (Bloor & Wood, 2006). Its main strength can also be seen as a weakness in less successful projects.

2.6.1.6. Experimental Research

This method consists of measuring the effects of independent variables on dependent variables either in the field or in controlled environments (Babbie, 1998; Singleton, 1988). It is directly associated with quantitative methods and is well suited for projects of limited scope and with well defined quantifiable variables. Key concepts in experiments are manipulation, control and comparison (Jones, 1996). Its fundamental goal is to establish cause and effect relationships.

Strengths are its potential to reach strong causal relationship inferences, control over extraneous variables, and ease of replication (Singleton, 1988).

Its main weaknesses are low generalizability, and artificiality (Babbie, 1998).

2.6.1.7. Surveys

The purpose of surveys is to collect data regarding opinions, preferences, perceptions, or other attributes associated to an object of study by asking questions to individuals familiar or affected by the object of study (Dillman, 2007; Jones, 1996). Surveys are quantitative in nature and can be descriptive, comparative, or explanatory (Jones, 1996). This data collection technique varies by administration method, technology used, which in turn have a direct effect on response rates (Bryman, 2004; Dillman, 2007). In explanatory surveys it is critical to select theoretically relevant variables (Jones, 1996).

2.6.1.8. Self Administered Questionnaires

Advantages of this survey method are its ease of administration, potential to reach large samples, sophisticated data analysis, and its reliability. (Singleton, 1988).

Disadvantages come from its lack of adaptability once administration is initiated, limitation of responses, necessity to limit number of questions to avoid respondent withdrawal (Bryman, 2004; Dillman, 2007). Also there are several implications that result from the questionnaire development that affect the outcome of surveys (Dillman, 2007).

2.6.1.9. Structured Interviews

Their advantage over self administered questionnaires is that it allows for probing; it has higher response rates; and the interviewer has the opportunity to clarify questions (Jones, 1996). However it has the increased risk of being affected by the "social desirability" effect (Jones, 1996).

2.6.1.10. In Depth Interviews/Naturalistic Inquiry

The in depth interviews, also called unstructured interviews, are used in qualitative studies. These interviews consist of guideline open ended questions, exploratory in nature, that allow latitude for emerging new topics (Lincoln & Guba, 1985). The objective is to reach theoretical saturation though multiple interviews of purposely sampled individuals that have relevance to the topic in study (Lincoln & Guba, 1985).

This research method has as its main strength its flexibility due to the exploratory nature of qualitative research.

This method shares the weaknesses described for ethnographic studies regarding uncertainties in the time for completion. Also cost of data transcription and analysis are indicated as problematic (Bryman, 2004).

2.6.1.11. Focus Groups

This method consists of conducting carefully planned discussion about a research topic with a select group of individuals of interest based on open ended questions (Morgan,

Krueger, & King, 1998). Focus groups are similar to in depth interviews in their flexibility and exploratory power, inherent to their qualitative nature (Bryman, 2004). It is well suited for testing and assumptions and exploring concepts (Krueger & Casey, 2000).

Again as with most qualitative methods its main advantage is its exploratory flexibility. It is seen as less artificial and less dependent on personal dynamics than in depth interviews (Bryman, 2004).

Its chief disadvantages are complexity in data transcription and analysis, difficulty to organize, potential group effects on responses, and potential individual discomfort (Bryman, 2004).

2.6.2. Relevance to the Study

Based on the literature reviewed for this research project it can be said that all of the methods and techniques described have been used in one or more research projects related to workspace. Mixed methods approaches have been used in the study of workspaces as well.

Although relevant to this study, some of the methods above might not be practical considering the stated scope and goals of the proposed research. That is the case of ethnography, and the use of in depth interviews as primary research methods. The lack of definition of potential results, and time frame to achieve theoretical saturation would

make it even harder to enlist participants. Cost and time issues also would deeply impact the researcher to the point of compromising the study.

Action research could be applied to similar studies. However, this method/research principle implies a preexisting problem related to a defined group that needs a solution. This was not the case in the current research. For the research proposal in question research topics and approaches to workspace studies were reviewed from the literature and a research gap was identified. Also, the intention of this research is to develop a methodology to evaluate workspace alternatives as well as test the relevancy of the units of analysis proposed in the theory, not necessarily problem solving.

In the case of experimental approaches, they simply do not respond to the needs of this proposal, as no causal relationships are sought.

The use of case studies is a relevant methodology that was not used in this research. In the case of multiple organizations participating in the research this method could have an important role as part of triangulation of the results. However, it also has time and cost implications inherent to qualitative studies. Also, one of the most difficult tasks in this research was enlisting participants.

The selected methods for this research are a self administered survey as a dominant element with focus groups as less dominant. The survey was adopted due to the explanatory nature of the research, for its potential to reach large sample sizes, and cost and time implications of the method. Focus groups were selected as a less dominant

method to address the relevancy of the workspace alternatives in question and to allow for some adaptation of the survey to different organizations prior to their administration. This selection of methods also builds upon proposed variables in the literature and survey instruments used in well known workspace studies.

Key factors for this choice of mixed methodology were: explanatory nature of the research; potential for using large sample sizes; cost implications to participant organizations; cost and time implications to the researcher; and necessity to validate the proposed survey instrument.

2.6.3. Relevance to Intended Audience

The intended audiences of this research are: scholars interested in the study of workspace planning and innovation as well as facility managers, strategic planners, designers, and managers, as they are typically decision makers in the planning processes for new workspaces and renovation of existing workspaces.

The methods selected are commonplace in environment and behavior studies. Key concerns for the first audience group are assumed to be with the rigor of research and adequacy of the adopted methodology to the research topic. Since the proposed study differs fundamentally from current approaches to workspace evaluations, methodological changes and adjustments can be seen as subjects for future studies.

Considering the second audience group the decision to adopt a dominant less dominant mixed method approach makes the research project more tangible and adaptable to their realities. Furthermore, this study serves as a response to concerns raised in the Fall 2006 and Fall 2007 Facility Management Industry Advisory Council's (FMIAC) meetings. These meetings were organized by the CRS Center of the College of Architecture and held at Texas A&M University. Concerns raised in the FMIAC meetings focused on broad generalizations and unwarranted assumptions when dealing with workspace planning and how they affected their workspace planning efforts.

3. METHODOLOGY

3.1. Research Design

The study consists of a mixed methodology design. Specifically, this research uses survey research as a dominant method and case studies as less dominant.

The design of the study acknowledges Sundstrom and Sundstrom's (1986a) two framework premises (Figure 3.1): that people and their physical environment form interdependent systems; and that people space relationships are dependent on the scale of units of analysis. It also takes into account Laing and Duffy's (1998) model (Figure 3.2), where they propose that workspace types are dependent on the variation of interaction and autonomy. This study assumes the semantic distinction between needs and preferences as relevant to the understanding of workspace choices.

Figure 3.1
Framework for Workspace Studies. Adapted from Sundstrom and Sundstrom (1986)

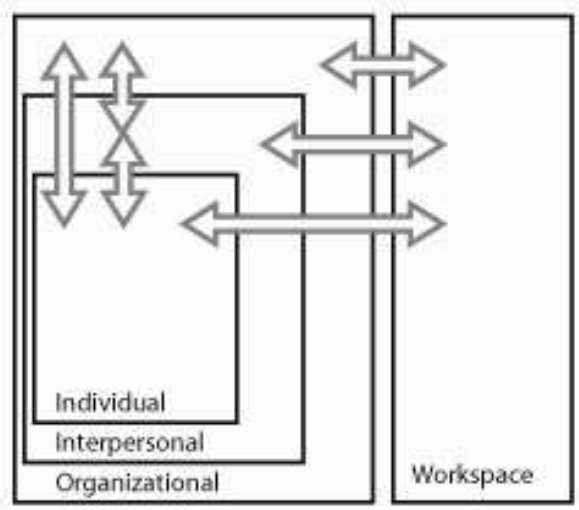
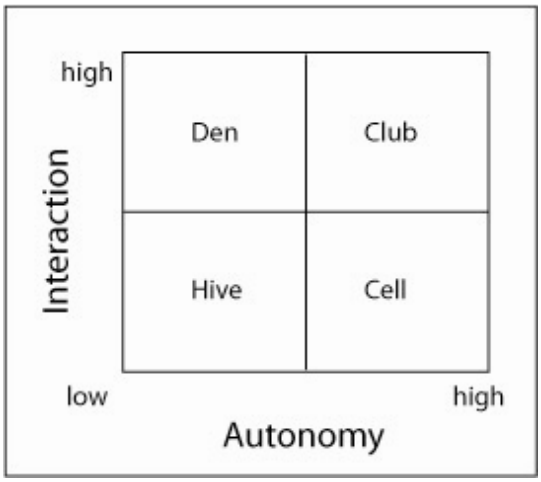


Figure 3.2
Laing and Duffy's Workspace Type Model



3.2. Survey

The dominant phase of the proposed study consisted of a web based survey of full time enrolled doctoral students attending a major state university in Texas. The full time criterion was defined to satisfy one basic assumption of this study. Doctoral students enrolled full time receive departmental assistantships, thus they are likely to have some form of workspace assignment.

The survey instrument consisted of five sections totaling eighty questions.

- Section one asked participants to rate on a five point scale the level of importance they attribute to their workspace needs in terms of the twenty one independent variables selected from the literature.

- In section two participants used a five point semantic differential scale to rate their current workspace in terms of the same twenty one variables.

- Section three was similar in structure to section one, however, in this section participants were asked to indicate their preferences regarding workspaces.

- Section four of this instrument dealt with workspace types and workspace alternatives. Participants were asked to indicate their current workspace type and alternative selected from literature. Four workspace types and five workspace alternatives were presented. In this section participants were also asked to indicate workspace type and workspace alternative choices as individuals, as part of their immediate work group, and as part of their organization. In addition participants were asked to rate in five point scales their level of satisfaction with their workspace; the effect their current workspace has on their performance; and to indicate their level of satisfaction with their job.

- The final section of the survey collected demographic information about the participants and allowed the input of comments and suggestions.

Three levels of data analysis were considered for the development of the data collection instrument. One level of analysis follows action research principles, in terms of identifying potential actionable workspace problems. The output at this level was intended to be a report to interested parties in the form descriptive statistics about current

spaces, as well as indicated needs and preferences. The two other levels were included primarily to enable testing of theoretical premises and ultimately respond to the research questions in this study.

Twenty one variables selected were grouped as interaction, autonomy and physical/environmental variables for methodological development purposes. These variables were assessed in three of the five survey sections.

3.2.1. Variable Selection

Variable selections made by different workspace related research authors vary in quantity, treatment, levels and application. Table 3.1 shows the variables proposed by selected authors. This study focuses mainly on individual needs, preferences and perceptions about their current workspaces and their association with choices of workspace types and workspace alternatives. Considering that most workspace literature is based on the study of existing environments some of the variables used in previous workspace studies did not directly apply.

One simple illustration of this matter is the case of a variable such as temperature. Its relationship to worker performance and satisfaction has been studied and recognized as a critical workspace factor. Multiple authors resort to asking questions about satisfaction with temperature in office environments, while monitoring temperature variations. Some of them even go through the refinements of asking about implications of dominant seasons (e.g. summer and winter) in relationship with office environment temperature.

Table 3.1
Workspace Variables Used by Selected Authors

Sundstrom & Sundstrom (1986) (behavioral research)	**Visher & Fisher (1995-2005)** (action research)	**Marans & Spreckelmeyer (1981)** (behavioral research)	**Davis & Szigeti (1997-2005)** (action research)	**Leaman & Bordass (1997-2001)** (action research)
Air quality	Air quality	Access to other people	Support for office work	Procurement route
Temperature	Thermal comfort	Lighting	Meeting and group effectiveness	Design and construction
Lighting	Lighting comfort	Materials of workstation	Sound	Initial occupancy
Privacy	Privacy	Amount of space	Visual environment	Occupant satisfaction
Furniture	Spatial comfort	Comfort of your chair	Thermal environment	Management perceptions
Noise	Office noise control	Amount of surface area	Indoor air	Energy and water consumption
Status symbols	Building noise control	Type of floor covering	Information Technology	Operation and management
Color		Color	Amenities	Maintenance and reliability
		Air quality	Facilities technology	Controls and controlability
		Style of furniture	Location	Design intentions
		Attractiveness	Access	Alterations made
		Ventilation	Wayfinding	Benchmark comparisons
		Air circulation		Strengths and weaknesses
		Aesthetic qualities		
		Storage		
		Heating		
		Number of outlets		
		Visual privacy		
		Conversational privacy		

However important, in the case of this study it would be clearly irrelevant to ask questions about temperature in a hypothetical office environment.

Therefore, variable selection in this study needed to be adapted from well known workspace studies. The solution to dealing with the cases of variables such as temperature, air quality, and lighting came from Building Use Studies (BUS) (Leaman & Bordass, 2001). Leaman and Bordass proposed to ask questions about user control over such variables as a factor that could affect satisfaction. Posing the questions about these critical variables in terms of needed and preferred control allowed for their inclusion in this study.

The final list of the twenty one variables used in this study is in table 3.2. This list results from merging the variables list proposed by each of the selected authors; eliminating redundancies; and finally determining the viability of data collection based on the nature of the proposed study as discussed above. As mentioned, selected variables were grouped as interaction, autonomy and physical/environmental variables for methodological development purposes. Some of the variables previously studied were subdivided to address specific issues pertaining to the theoretical groundings and assumptions of this study. The variable “Meeting and group effectiveness” used by Davis (2005) is one such example.

Table 3.2
List of Selected Variables

Group	Variables
Interaction	Visual Privacy Conversational privacy Amount of space assigned Office noise Interaction with coworkers Exchange of information with coworkers Team/group work
Autonomy	Formal meeting space Informal meeting space Schedule flexibility Remote work Paperless processes Work deliverables Interaction with people outside of workgroup
Physical/ environmental	Control over air quality Control over lighting Control over ambient temperature Overall office comfort Work surface Work storage Personal storage

3.2.2. Workspace Selection

For the purposes of testing the relevance of the proposed variable grouping, as well as the effects of autonomy and interaction in workspace choice, workspaces in this study are divided into two categories: workspace types, as they relate to the general arrangement of the workspace they work in; and workspace alternatives, as these relate to their individual workspace assignments. The selection ranges from traditional workspace approaches, to remote workspaces.

The workspace types used in this study, as defined by Laing and Duffy (1998), are:

Cell – highly cellular enclosed or highly individually used open workstations with high screening or partitions (figure 3.3). Also described as a low interaction and high autonomy workspace type.

Club – diverse complex and manipulable range of settings based on a high variety of tasks. Space must be zoned and planned to suit diverse use (figure 3.4). Also described as a high interaction and high autonomy workspace type.

Hive – open ganged (4 or 6 pack), minimal partitions, maximal filing, Imposed simple space standards (figure 3.5). Also described as a low interaction and low autonomy workspace type.

Den – Group space or rooms, medium filing. Complex and continuous spaces, incorporating meeting spaces and workspaces (figure 3.6). Also described as a high interaction and low autonomy workspace type.

Figure 3.3
Cell Workspace Type

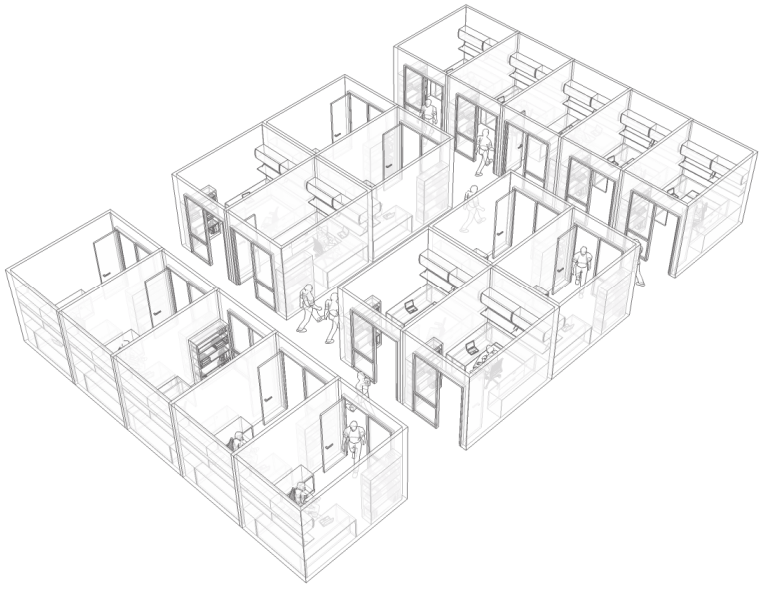


Figure 3.4
Club Workspace Type

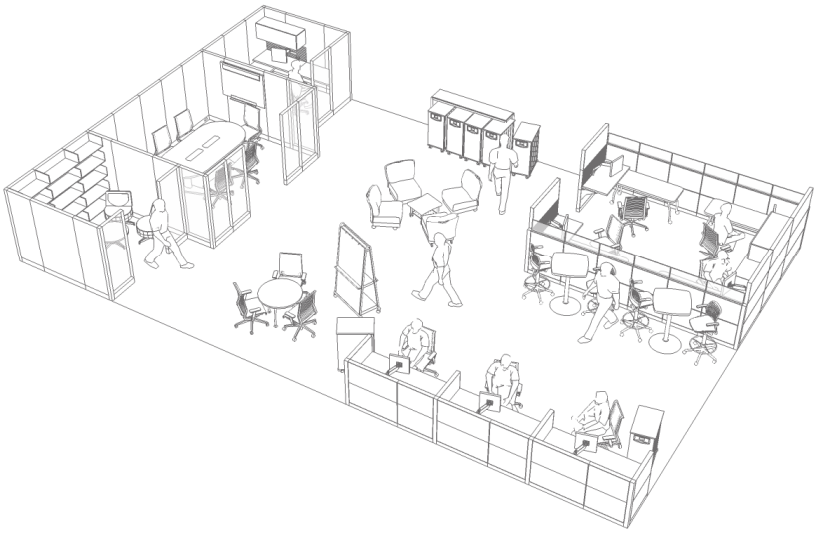


Figure 3.5
Hive Workspace Type

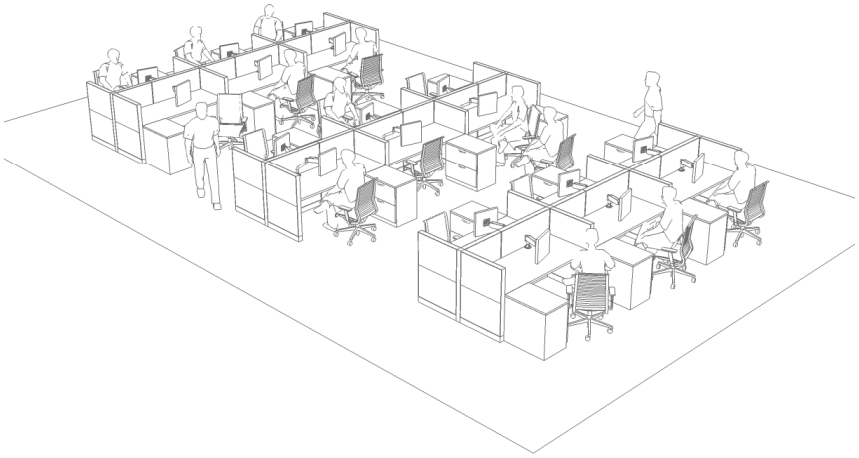
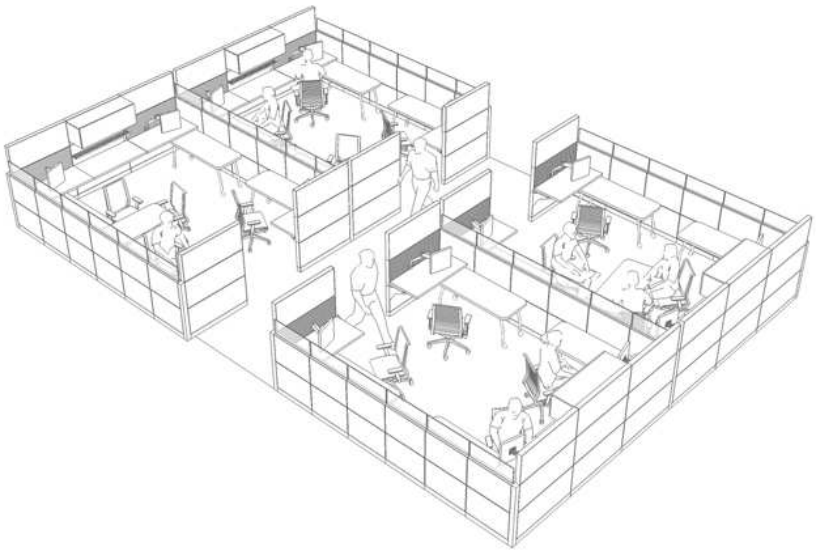


Figure 3.6
Den Workspace Type



Workspace alternatives adopted for this study were based on a review of the literature (Apgar, 1998; Turner & Myerson, 1998; J. Vischer, 1996; Wineman, 1982). Given the possible status connotations or stigma of common workspace alternatives, terminology such as office and cubicle were replaced with less loaded terminology. The workspace alternatives used in this study are:

Individual fully enclosed space – fully enclosed space. Only one individual assigned to the space.

Individual partitioned space – enclosed spaces. Partition heights vary to satisfy privacy needs of users. Only one user assigned per space. Can be configured to support group work.

Assigned shared partitioned space – partially enclosed spaces. Partition heights vary to satisfy privacy needs of users. More than one user assigned to the space (based on work schedules). Can be configured to support group work.

Unassigned shared partitioned space – level of enclosure and partitioning height vary. Configured to support specific tasks. Space assigned to a defined type of user or team. Use determined by need.

Mobile work environment – no specific space assignment. Work can be done remotely or in the office. Paperless, web processes are highly supported. Variety of work settings available to support individual needs.

3.2.3. Data Collection

Data for this study was collected from a major academic institution in the state of Texas. Collection of data was done through a web based survey. The survey instrument (Appendix A) was adapted from well known post occupancy evaluation and comparison study instruments such as Marans and Spreckelmeyer et al (1981), Vischer (1996), Brill and Margulis (1984 a, 1984 b), Laing and Duffy (1998), and Building Owner Managers Association International (BOMA) (1999). These instruments were considered relevant for the research due to their focus on the selected workspace types and workspace alternatives of this study.

Visual preference elicitation was incorporated in the case of workspace types. This technique has been explored in architectural programming (Sanoff, 1977) and in environment and behavior studies (Marans et al., 1981). For improved visualization in range of web browsers, workspace type images had a size of 650 by 470 pixels and were embedded as hidden layers in the active server code (ASP).

Given specific features that needed to be incorporated in the survey a decision was made not to use a third party web survey provider. For this study the web interface was custom made and fully developed in ASP. The survey engine consisted of an Microsoft Access database with custom tables and queries connected to the web pages through an ADODb database abstraction protocol. The survey was hosted on a Microsoft server, provided by the College of Architecture.

The web based survey followed Dillman's tailored design method (2007). Since personal information of participants was not relevant to this research, as well as to protect respondents, participation was anonymous.

3.2.4. Data Analysis

Each of the phases in this study required separate data analysis procedures.

Data analysis of the survey consists of four steps. First step consisted of the basic descriptive statistics. The second step was categorical variable analysis through crosstabs and Chi Square measures of association. Third factor analysis was conducted to verify the validity of the proposed grouping (interaction, autonomy and physical/environmental). Finally crosstabs and Chi Square measures of association were used to study the effects of the resulting factors on the workspace type and workspace alternative choices made by participants.

The categorical variable portion of the analysis allowed the researcher to reach conclusions about potential associations hypothesized and the interaction between the variable being studied. Contingency tables were used to test associations and when all necessary categorical statistical test assumptions were met, Chi Square was used to assess the association between variables. The factor analysis tested the levels of correlation between variables; tested the fit of the data to potential groupings; eliminated redundant and irrelevant variables; identified critical factors within the data; and finally provided loading values of the variables within identified factors. The last part of the

statistical analysis assessed the existence of differences between preferences and needs, and their respective influences on the workspace type and workspace alternative choices made by participants.

The process of data analysis of the web based survey was performed using SPSS 15. Issues regarding internal validity inherent to survey studies were dealt with by using the most conservative categorical data sample size calculations (Sommer & Sommer, 1991).

3.2.5. Pre-test of Instrument

Two pilot studies were conducted in academic office environments. The pilot studies served three basic purposes. Test the clarity of wording of the survey instrument. Test the understanding of concepts presented in the questions. And the third and final objective was the assessment of web interface functionality.

Wording and concepts: The pilot study suggested that the wording in four questions in the needs and four in the preferences section of the survey instrument needed restructuring. These questions referred to general architectural concepts that were not fully understood by participants. Four of the semantic differentials proposed in the section evaluating participants' current workspace had to be reworded for the same reasons.

Web interface: The pilot study indicated the necessity of general formatting and technical modifications to the survey instrument. General formatting modifications arose

from participants' difficulties in reading the questions due to initial color selection of text. Also there were indications that vertical proximity of questions against the same white background also increased reading difficulties. Both issues were addressed by altering the Cascading Style Sheets (CSS) associated with the web interface.

Technical modifications arose from the display of images associated with workspace types and with the close window scripts due to different browser functionality. In the first case images were displayed in separate browser windows scripted as "pop ups". Participants had to disable pop up blockers in Mozilla Firefox to view images associated with the instrument. The solution found was to embed images in different layers and control their display by adding "on click" behaviors to thumbnails. The second problem emerged from the fact that Mozilla Firefox did not, at the time, support any form of close window script. Therefore the only solution possible was to remove all instances of such scripts and replace them with textual instructions.

3.3. Focus Groups

Focus groups were conceptualized to obtain qualitative data regarding workspace choices and the influence that key theories and assumptions of this study have on such choices. The objective of the focus groups was to concentrate on understanding how workspace choices are influenced by the units of analysis adopted in the study; the constructs of interaction and autonomy; the assumption of distinction between needs and preferences; and the role workspace has on productivity as a general concern of the field.

Five topics were specifically addressed by the focus group protocol:

1. Perceived necessary levels of interaction for the type of work conducted by participants;

2. Perceived necessary levels of autonomy for the type of work conducted by participants;

3. Physical factors affecting participant's productivity;

4. The impact of needs and preferences on individual workspace choice;

5. The impact of the units of analysis on individual workspace choice.

As an initial strategy four focus groups were planned. Each group was expected to have a minimum of five Ph.D. students participating and last between forty five minutes to one hour. No compensation was offered for participation in the focus groups. The base criterion for each of the focus groups was that all participants had to work in similar workspace types as defined by Laing and Duffy (1998).

3.3.1. Data Analysis

Data analysis of the focus groups consisted of content analysis (Krippendorff, 2004; Lincoln & Guba, 1985). For this portion of the study focus groups a twelve question protocol was developed (Appendix B) that served as guideline for the discussions. Probe questions were asked based on specific discussions and necessary clarifications during

the focus groups. The content of the audio recordings were transcribed. Coding consisted of two levels. The first code was for general topics and consisted of five categories: interaction, autonomy, productivity, unit of analysis, and needs versus preferences. The second level of code was derived from the discussion and was used to identify common topics within the first level categories. Analysis and resulting findings discussion of focus groups was based on the two levels of codes described.

3.3.2. Pretest of Protocol

Focus group protocol was assessed for clarity of wording and relevancy of questions to the study. Assessment consisted of presentation of the protocol questions to three doctoral students, in separate occasions, that qualified for the survey portion of the study, followed by discussions on their understanding of the questions.

As a result one closed ended question was identified and its wording modified to offer a discussion opportunity in the focus groups. Minor changes were suggested in the wording of other questions that improved understanding of the general topics. The final protocol was then submitted for approval by the institutional review board of Texas A&M University.

3.4. Limitations

This study was limited to the educational settings, academic departments, and individuals who agreed to participate in this study. The findings of this study are limited to generalizations associated with the population of which the sample is a part. The

workspace alternatives and types used in this study were selected based on literature review and represent part of the universe of workspace types and alternatives available. Reduction of individual researcher and participant biases towards the selected workspace types and alternatives were addressed through the use of alternative wording. Multiple wording iterations were pursued up to their final versions in the survey instrument. Chosen wording is still subject to perception of bias.

It is acknowledged that integrating a full post occupancy evaluation with a study on declared individual needs, preferences, and choices of workspace types and workspace alternatives could provide clarification regarding the relationship between satisfaction with existing spaces and choice of alternatives. However, collection of physical and attitudinal data in the form of a full post occupancy evaluation would exceed the scope of the present research, as the intention is to develop a methodology to access workers preferences and attitudes toward workspace alternatives. External validity issues are considered to be an inherent problem of workspace research, thus also a limitation of the study.

3.5. IRB

The described study falls within the scope of human subject research. Therefore it was required that all proposed phases of the study be approved by the Institutional Review Board (IRB) of Texas A&M University. As presented, the research qualified for exemption of full IRB review. Approval was sought and obtained under protocol number 2007-426 prior to the administration of the survey in the pilot studies. Amendments to

the IRB protocol were sought for all iterations of this research's data collection instruments until their final form was achieved. This research was fully compliant with the Institutional Review Board rules.

4. SURVEY RESULTS

This web based workspace survey had as its target population full time doctoral students attending a major state university in Texas. According to the office of the registrar 3252 students were enrolled for the spring semester of 2008. Of this group 2388, an equivalent of 73.4% of all doctoral students, met the criteria of being enrolled full time as doctoral students. A list of names and emails of these students was requested from the university. The office of the registrar delivered a list with 928 full time doctoral students, an equivalent of 28.5% of all doctoral students, based on student who requested restriction to private information upon enrollment.

Dillman's tailored design method (2007) was used as the data collection protocol. First a notice was sent to the list of participants indicating the relevance and scope of the study and that four notices with links to the web based survey would follow. This notice also indicated the incentives for participation in the form of three gift certificate drawings totaling $275 dollars.

Each potential participant was assigned an invitation number on the Microsoft Access database created for the study. This allowed tracking for those who responded, who had email delivery failures and formal participation declines. In turn, it enabled better management of email mergers. Subsequent notices were sent only to individuals that had no email delivery failures, had not formally declined participation and had not responded to the survey up to the time each notice was sent.

Six weeks of data collection followed the first survey notice. A total of 388 responses were obtained in this period. 16.25% of the full time doctoral students enrolled for the spring semester of 2008. Considering that a total of 1153 doctoral students were contacted the response rate to the survey was of 33.65%.

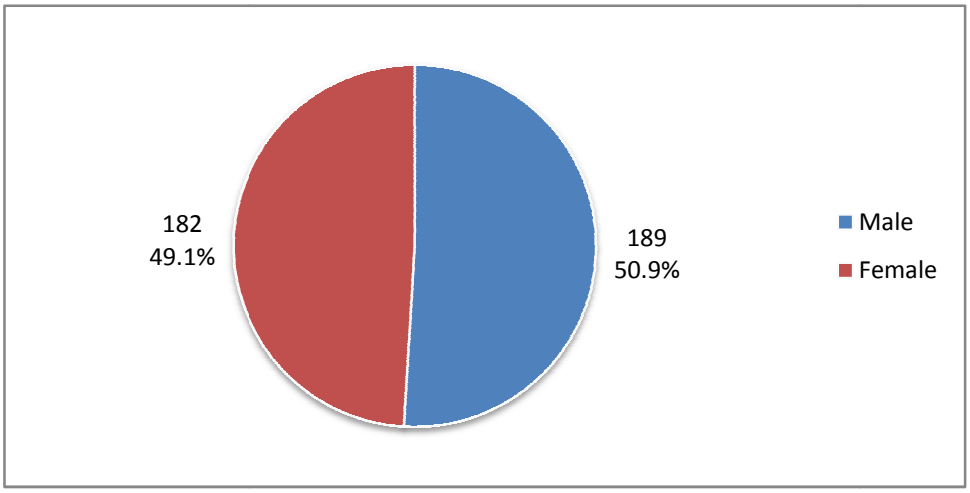
Responses exceeded the two sample size requirement scenarios calculated for this study. Scenario one consisted of estimating sample size based on the most conservative estimations of response variance for categorical variables given a population of 2388 individuals. In this scenario using Cochran's formulas (Bartlett, Kotrlik, & Higgins, 2001) the required sample was 331 participants. Scenario two consisted of estimating the response variance based on the actual survey instrument developed for the study and the five point scales adopted. Using the same formula the required sample was 246 participants.

Pre-analysis of the responses showed that, as expected from most other surveys, there were incomplete responses. As a general criterion responses with five or more incomplete answers were excluded from the study. Seventeen responses were excluded under this criterion. The final count of valid responses was reduced to 371 and the final valid response rate was 32.18%. The number of valid responses still met the sample size requirements in both scenarios.

4.1. Response Demographics

Doctoral students from the 10 colleges housed in the university responded to the survey. Valid responses were comprised of 50.9% of males and 49.1% of females (figure 4.1).

Figure 4.1
Gender of Respondents



In terms of age group (figure 4.2) the majority of respondents, 66.0%, indicated that they were ages 21-30 followed by the 31-40 group with 27.5%, totaling 93.5% of participants. The distribution of participants across the time in the program category was more dispersed than the age groups (Figure 4.3). Second year doctoral students were the largest contributing group with 23.7 % of responses. This group was followed by third and fourth year doctoral students with 17.3% and 15.9% of the responses respectively.

The majority of doctoral students indicated they were either slightly satisfied 40.3% or very satisfied 38.6% with their current occupation (Figure 4.4). It can be argued that doctoral students would be expected to have above neutral levels of satisfaction with

their current job. The argument is supported by the fact that their current occupation is temporary and associated to a choice of career path rather than a job.

Figure 4.2
Age Groups

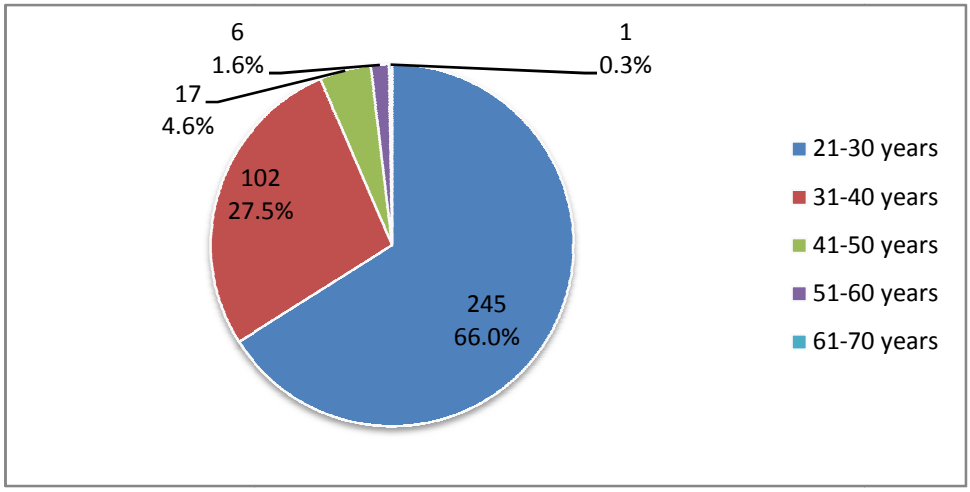


Figure 4.3
Time in the Doctoral Program

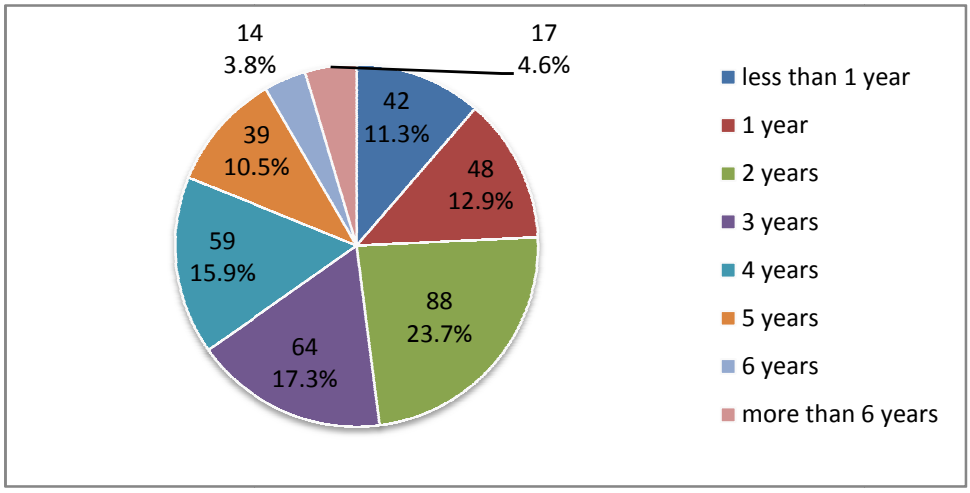
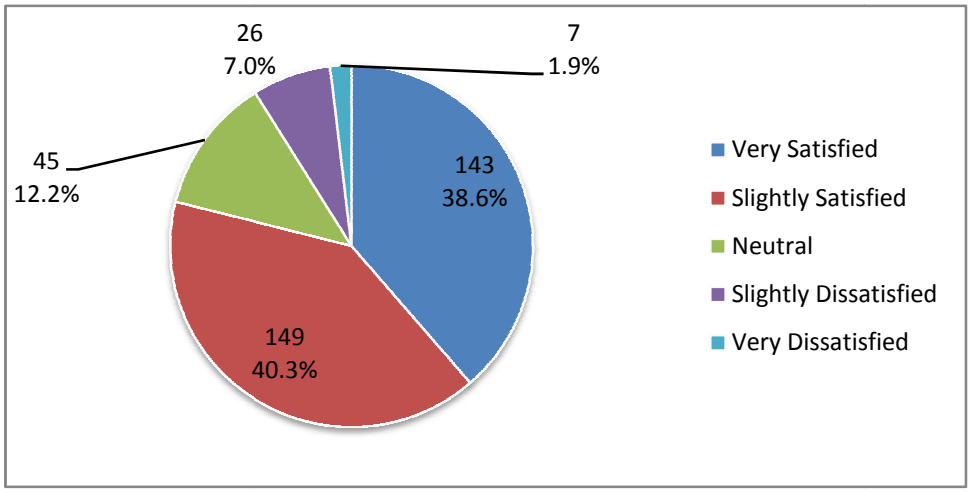


Figure 4.4
Job Satisfaction



4.2. Current Workspaces

There was a good balance of participants that reported currently working on each one of the four selected workspace types (Figure 4.5). The workspace type classified as the "Den" was identified by the largest group of respondents as their current workspace, 35.0%. This is over 10% more than any of the other workspace types.

In the case of the workspace alternatives (Figure 4.6), "mobile work environment" was reported the least number of times as a participant's current situation. Only 4.3% of the participants reported using this workspace alternative. This is close to 15% less than "unassigned partitioned space," the second lowest reported alternative; and over 25% less than "assigned shared partitioned space" the highest reported current workspace alternative.

Figure 4.5
Current Workspace Type

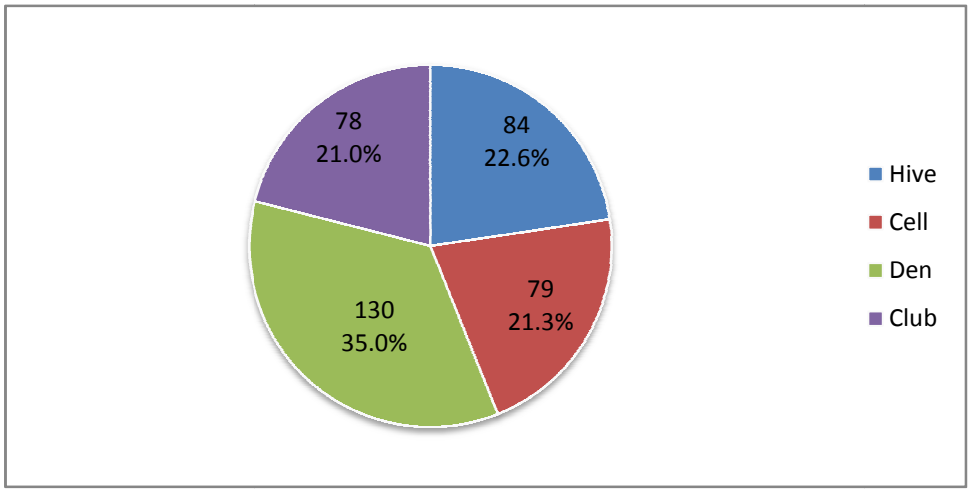
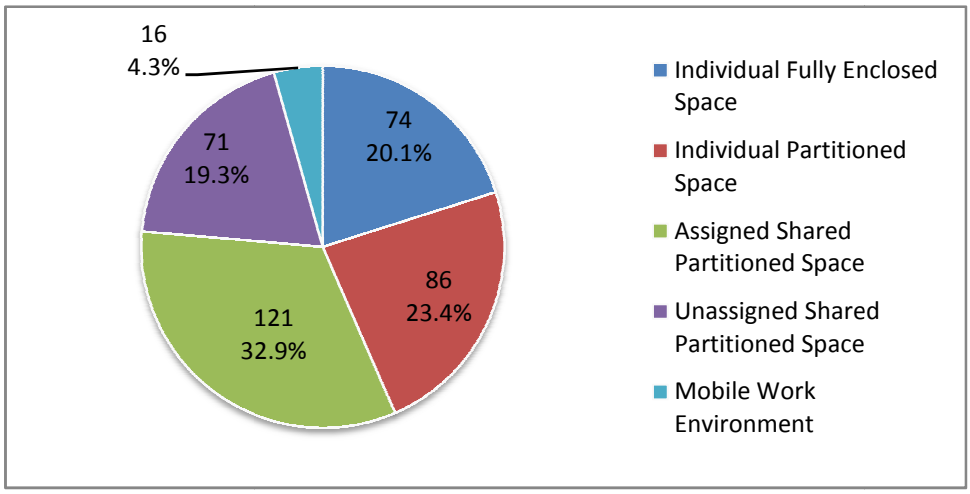


Figure 4.6
Current Workspace Alternative



The responses to the question about doctoral student satisfaction with their current workspace type and satisfaction (Figure 4.7) with their current workspace alternative (Figure 4.8) yielded very similar results. In both cases the majority of participants were either very satisfied or slightly satisfied with their current workspaces. Regarding

workspace types 43.4% of participants indicated that they were slightly satisfied and 22.8% indicated that they were very satisfied with their current situation. Regarding workspace alternatives 43.9% of participants indicated they were slightly satisfied and 20.7% indicated being very satisfied with their current condition.

Figure 4.7
Satisfaction with Workspace Type

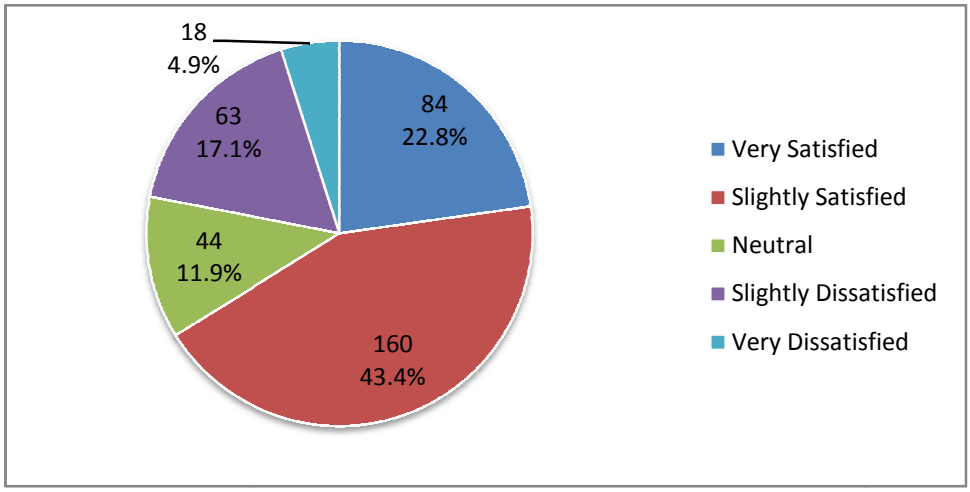
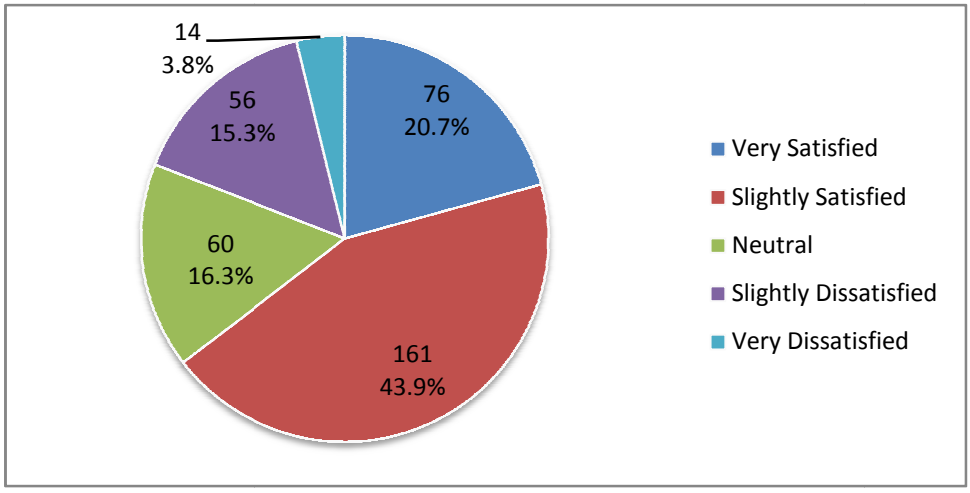


Figure 4.8
Satisfaction with Workspace Alternatives



When asked to evaluate how their productivity was effected by their workspaces, there were few differences between the effect described for workspace type and workspace alternative. The percentage of participants that indicated that their current workspace type and alternative had a positive effect on their productivity was higher than those indicating negative effects. For workspace types 43.7% participants indicated positive effects compared to 31.0% who reported negative effects (Figure 4.9). In the workspace alternatives, positive effects were reported by 47.4% of respondents and negative effects on productivity were reported by 29.3% of participants (figure 4.10).

Figure 4.9
Productivity Workspace Type

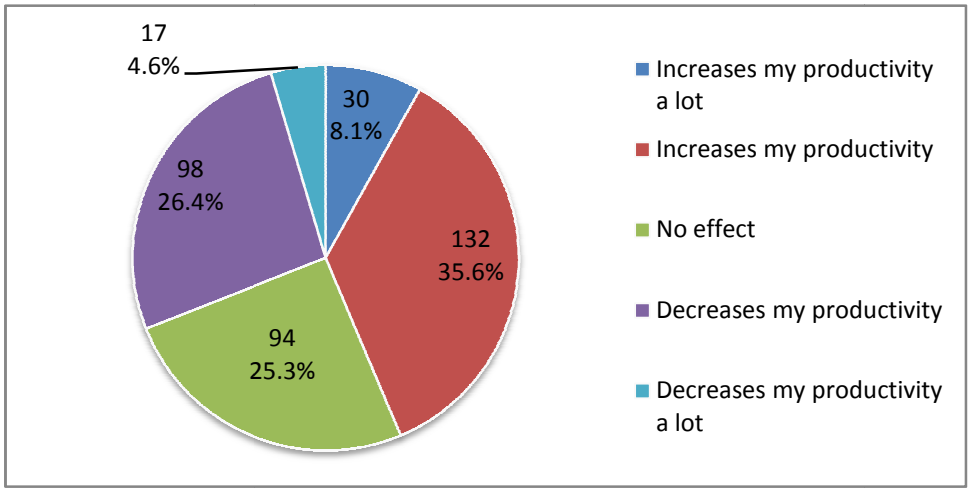
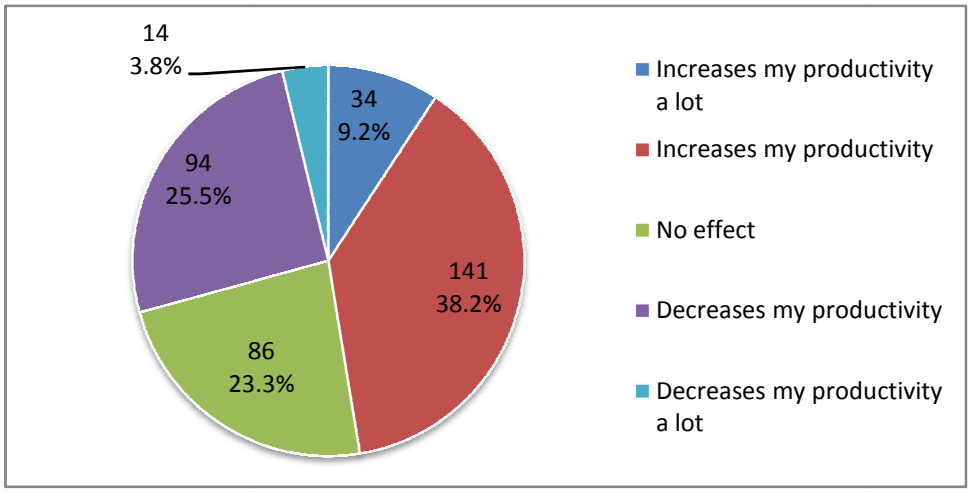


Figure 4.10
Productivity Workspace Alternative



4.2.1. Satisfaction and Workspaces

By cross tabulating the data from current workspace type and indicated levels of satisfaction (Table 4.1) it was found that a higher percentage of “club” and “cell” users reported being “very satisfied” with their workspaces, 34.6% and 34.2% respectively. However, collapsing the satisfaction categories into positive, neutral, and negative indicators allows for a different evaluation. In this situation, 83.6% “cell” users ranked their workspace type positively in terms of satisfaction compared to 67.9% of the “club” users. In fact a greater percentage of “den” users described a positive satisfaction with this workspace type than “club” users. With the exception of the “hive” workspace type on all others the majority of users reported positive levels of satisfaction with their current situation.

When looking at the crosstabulation of workspace alternatives (Table 4.2) and the indicated levels of satisfaction it was found that on all of the alternatives the majority of its user's indicated positive levels of satisfaction. A higher percentage of "individual fully enclosed space" users (82.4%) indicated being positively satisfied with their situation than any of the other alternatives. Also, "Unassigned Shared Partitioned Space" was the alternative with most users indicating negative satisfaction levels 25.7%.

4.2.2. Productivity and Workspaces

By performing the crosstabulation of the data from current workspaces types and indicated effects on productivity (Table 4.3) it was found that the cell was the only workspace type that had the majority of its users (59.5%) reporting a positive effect on productivity. At the same time, the hive workspace type was the only type that had the majority of its users (51.2%) indicating a negative impact on their productivity.

In the case of the workspace alternatives (Table 4.4) under study "Individual Fully Enclosed Spaces" had the majority of its users (59.5%) reporting a positive effect on productivity. The "mobile work environment" had 50% of its users reporting a positive effect on productivity. In terms of negative impacts on productivity the "Individual Fully Enclosed Space" was the alternative with the lowest percentage of its users describing this effect. For all other alternatives the percentage of users reporting negative impacts on productivity fell in a range between 31 and 37%.

Table 4.1
Current Workspace Type * Satisfaction with Current Workspace Type Crosstabulation

Current Workspace Type		Satisfaction with current workspace type					Total
		Very Satisfied	Slightly Satisfied	Neutral	Slightly Dissatisfied	Very Dissatisfied	
Hive	Count	9	25	17	21	11	83
	% within Current Workspace Type	10.8%	30.1%	20.5%	25.3%	13.3%	100.0%
Cell	Count	27	39	4	7	2	79
	% within Current Workspace Type	34.2%	49.4%	5.1%	8.9%	2.5%	100.0%
Den	Count	21	70	11	24	3	129
	% within Current Workspace Type	16.3%	54.3%	8.5%	18.6%	2.3%	100.0%
Club	Count	27	26	12	11	2	78
	% within Current Workspace Type	34.6%	33.3%	15.4%	14.1%	2.6%	100.0%
Total	Count	84	160	44	63	18	369
	% within Current Workspace Type	22.8%	43.4%	11.9%	17.1%	4.9%	100.0%

Table 4.2
Current Workspace Alternative * Satisfaction with Current Workspace Alternative Crosstabulation

Current Workspace Alternative		Satisfaction with current workspace alternative					Total
		Very Satisfied	Slightly Satisfied	Neutral	Slightly Dissatisfied	Very Dissatisfied	Very Satisfied
Individual Fully Enclosed Space	Count	29	32	7	5	1	74
	% within Current Workspace Alternative	39.2%	43.2%	9.5%	6.8%	1.4%	100.0%
Individual Partitioned Space	Count	11	43	12	17	2	85
	% within Current Workspace Alternative	12.9%	50.6%	14.1%	20.0%	2.4%	100.0%
Assigned Shared Partitioned Space	Count	26	46	23	19	5	119
	% within Current Workspace Alternative	21.8%	38.7%	19.3%	16.0%	4.2%	100.0%
Unassigned Shared Partitioned Space	Count	8	31	13	14	4	70
	% within Current Workspace Alternative	11.4%	44.3%	18.6%	20.0%	5.7%	100.0%
Mobile Work Environment	Count	1	8	4	1	2	16
	% within Current Workspace Alternative	6.3%	50.0%	25.0%	6.3%	12.5%	100.0%
Total	Count	75	160	59	56	14	364
	% within Current Workspace Alternative	20.6%	44.0%	16.2%	15.4%	3.8%	100.0%

Table 4.3
Current Workspace Type * Current Workspace Type Effect on Productivity Crosstabulation

Current Workspace Type		Current workspace type effect on productivity					Total
		Increases my productivity a lot	Increases my productivity	No effect	Decreases my productivity	Decreases my productivity a lot	
Hive	Count	4	14	23	35	8	84
	% within Current Workspace Type	4.8%	16.7%	27.4%	41.7%	9.5%	100.0%
Cell	Count	12	35	18	9	5	79
	% within Current Workspace Type	15.2%	44.3%	22.8%	11.4%	6.3%	100.0%
Den	Count	4	55	34	34	3	130
	% within Current Workspace Type	3.1%	42.3%	26.2%	26.2%	2.3%	100.0%
Club	Count	10	28	19	20	1	78
	% within Current Workspace Type	12.8%	35.9%	24.4%	25.6%	1.3%	100.0%
Total	Count	30	132	94	98	17	371
	% within Current Workspace Type	8.1%	35.6%	25.3%	26.4%	4.6%	100.0%

Table 4.4
Current Workspace Alternative * Current Workspace Alternative Effect on Productivity Crosstabulation

Current Workspace Alternative		Current workspace alternative effect on productivity					Total
		Increases my productivity a lot	Increases my productivity	No effect	Decreases my productivity	Decreases my productivity a lot	
Individual Fully Enclosed Space	Count	16	35	13	9	1	74
	% within Current Workspace Alternative	21.6%	47.3%	17.6%	12.2%	1.4%	100.0%
Individual Partitioned Space	Count	4	30	22	25	5	86
	% within Current Workspace Alternative	4.7%	34.9%	25.6%	29.1%	5.8%	100.0%
Assigned Shared Partitioned Space	Count	8	45	28	36	4	121
	% within Current Workspace Alternative	6.6%	37.2%	23.1%	29.8%	3.3%	100.0%
Unassigned Shared Partitioned Space	Count	3	24	19	20	3	69
	% within Current Workspace Alternative	4.3%	34.8%	27.5%	29.0%	4.3%	100.0%
Mobile Work Environment	Count	3	5	3	4	1	16
	% within Current Workspace Alternative	18.8%	31.3%	18.8%	25.0%	6.3%	100.0%
Total	Count	34	139	85	94	14	366
	% within Current Workspace Alternative	9.3%	38.0%	23.2%	25.7%	3.8%	100.0%

4.3. Choice of Workspace Types

Choices made by participants of this study were recorded at three different units of analysis. Participants were asked to choose between four workspace types as their workspace considering:

a) their individual preferences;

b) their immediate workgroup;

c) And the organization for which they currently work.

Across the three units of analysis, the “hive” workspace type was least preferred of the alternatives. When asked to choose as individuals the “cell” workspace type was the most preferred alternative, being selected by 47.4% of the participants (Figure 4.11). However, when asked to choose considering their immediate workgroup (Figure 4.12) and as part of their organization (Figure 4.13) most participants preferred the “club” workspace type.

Figure 4.11
Individual Workspace Type Choice

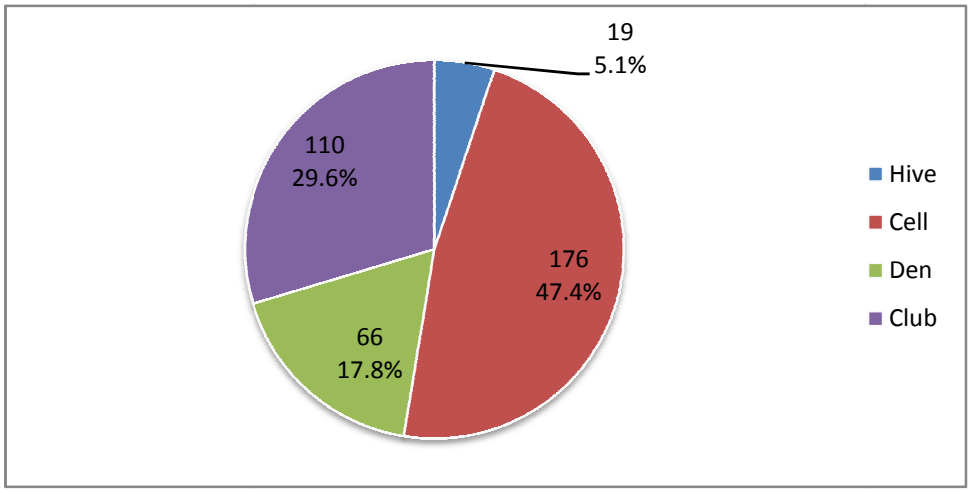


Figure 4.12
Work Group Workspace Type Choice

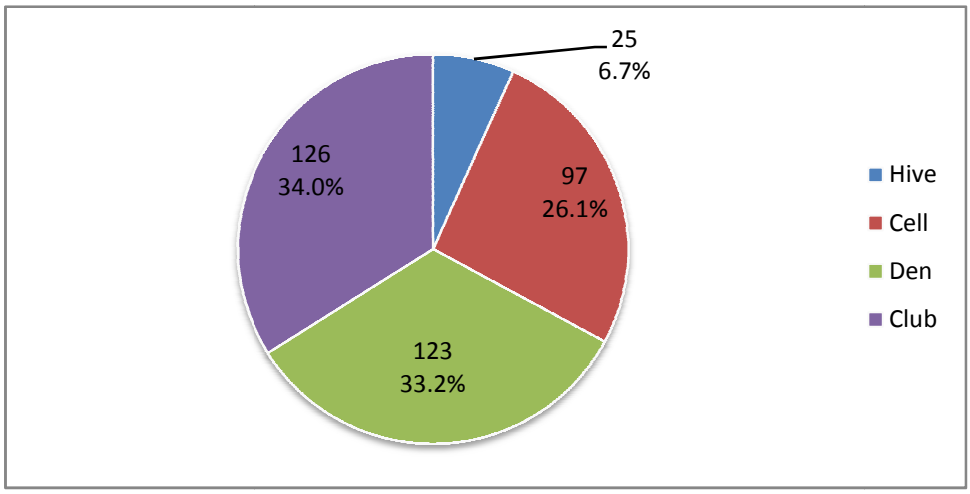
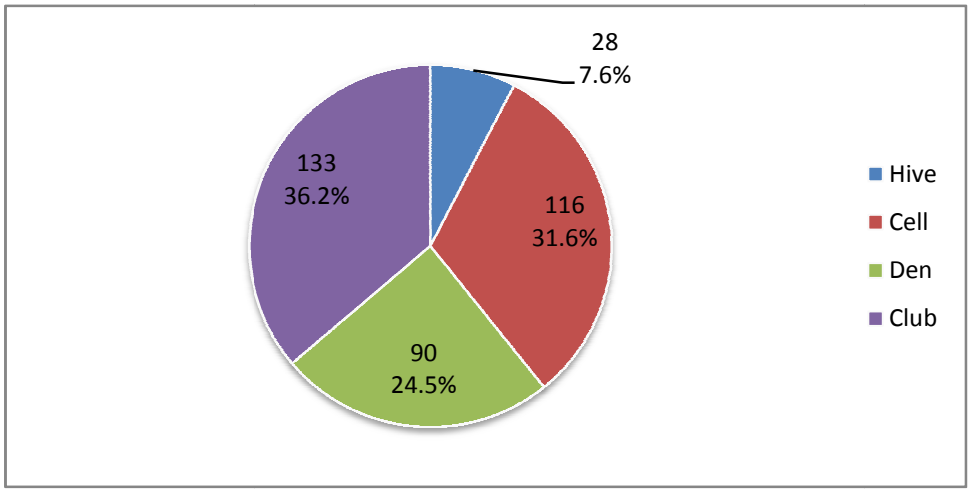


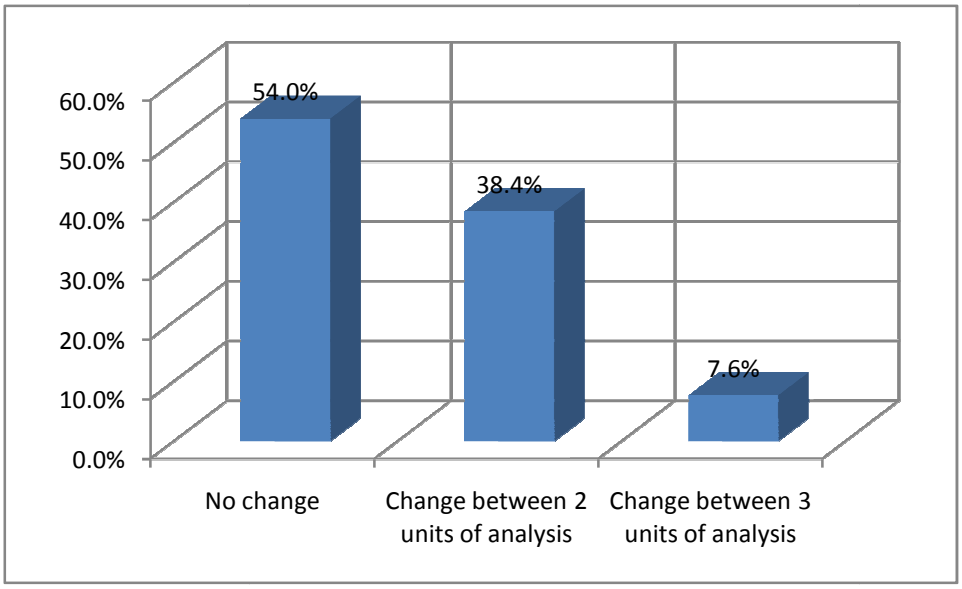
Figure 4.13
Organization Workspace Type Choice



From this data four variables were computed through comparison of choices made at each of the units of analysis. Changes in choices made by participants comparing individual and interpersonal workspace type choices; changes in choices made by participants comparing individual and organizational workspace type choices; changes in choices made by participants comparing organizational and interpersonal workspace type choices; and finally changes in choices made across the three units of analysis.

As shown in figure 4.14 it was possible to verify that the majority of participants (54.0%) maintained choices across the three units of analysis in study. 38.4% chose differently between at least two of the three units of analysis. Only 7.6% of participants had different choices for every one of the three units of analysis studied.

Figure 4.14
Workspace Type Choice



Results indicate that a doctoral student is more likely to maintain his or her choice of workspace type at the possible three comparison combinations than he is to change. The odds of change in choice when comparing individual and interpersonal choices are .62 to 1. The odds of change in choice when comparing individual and organizational choices are .54 to 1. The odds of change in choice when comparing interpersonal and organizational choices are .35 to 1. The overall odds of change in choices across the three units of analysis studied are .85 to 1.

Contrary to what was hypothesized, this result was an indication of possible association between the workspace type choices made by participants as individuals, as part of their immediate workgroup and as part of their organizations. The existence of such association of choices was tested by the crosstabulation of the pair of units of analysis

within workspace type choices made by participants (Appendix C) and their respective Chi square and significance levels calculations (table 4.5).

Table 4.5
Workspace Type Choice Association

Association tested	Chi square	Significance
Individual interpersonal	256.837	.000
Individual organizational	273.978	.000
Interpersonal organizational	397.922	.000

As it can be seen from table 4.5, significance levels of association based on the Chi square values are all smaller than .01. This result strongly indicates that there is a significant association between the workspace type choices made at the three combinations of units of analysis studied. All associations were significant at a 99% confidence level.

4.4. Choice of Workspace Alternatives

Similar to the workspace types, choices of workspace alternatives made by participants were recorded at three different units of analysis. Participants were asked to choose between five workspace alternatives as their workspace considering their individual preferences, their immediate workgroup and the organization for which they currently work.

Across the three units of analysis the “Unassigned Shared Partitioned Space” and “Mobile Work Environment” workspace alternatives were the least preferred of the alternatives. When asked to choose as individuals (Figure 4.15) the “Individual Fully Enclosed Space” workspace alternative was the most preferred alternative, being selected by 33.8% of the participants. However, when asked to choose considering their immediate workgroup (Figure 4.16) and as part of their organization (Figure 4.17) most participants indicated preference for “Individual Partitioned Space” workspace alternative.

Figure 4.15
Individual Workspace Alternative Choice

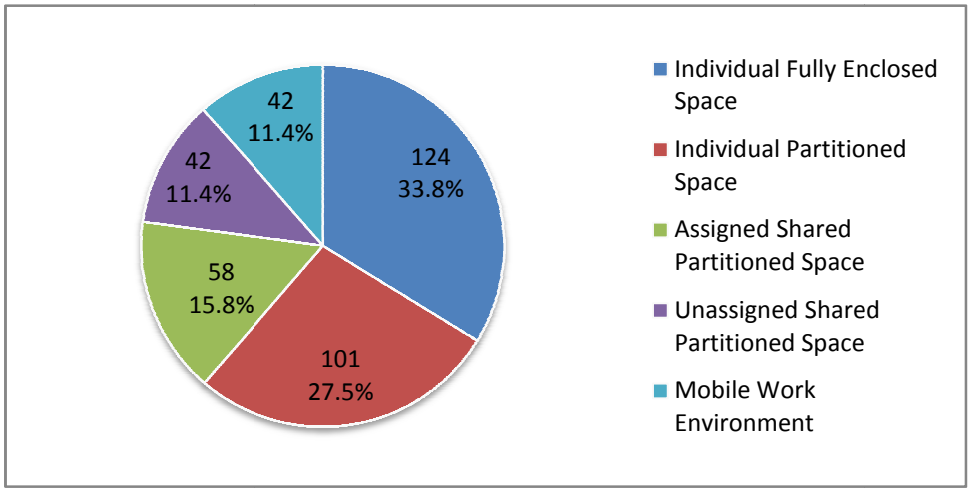


Figure 4.16
Work Group Workspace Alternative Choice

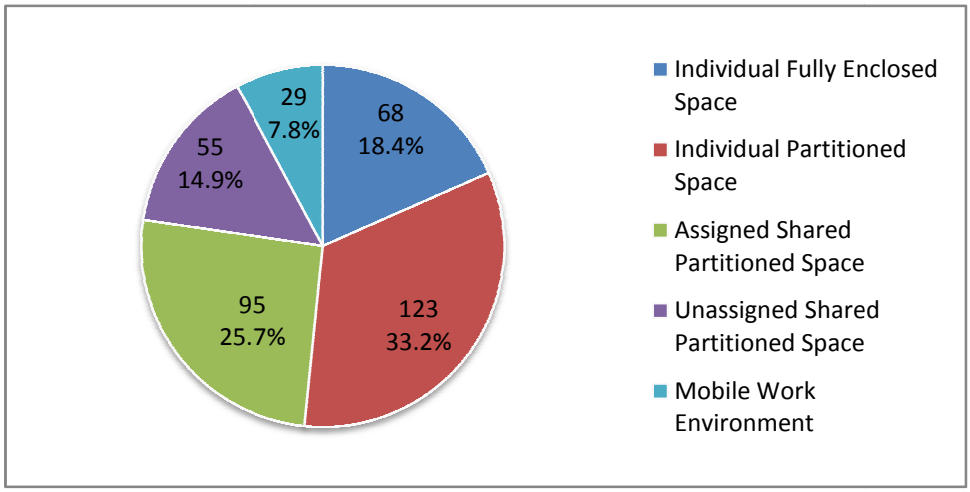
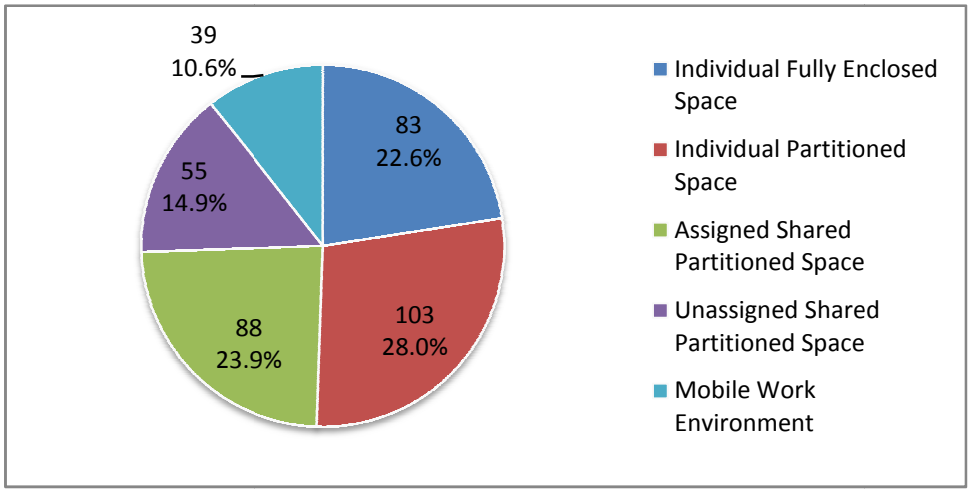


Figure 4.17
Organization Workspace Alternative Choice

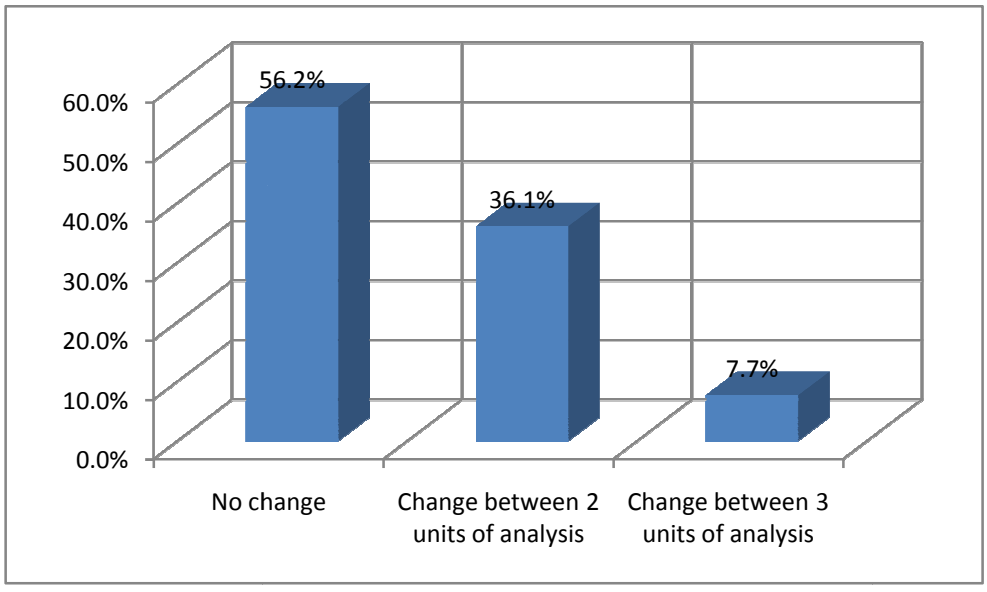


Again, similar to the procedure followed for the workspace types, from this data four variables were computed through comparison of choices made at each of the units of analysis: Changes in choices made by participants comparing individual and

interpersonal workspace alternative choices; changes in choices made by participants comparing individual and organizational workspace alternative choices; changes in choices made by participants comparing organizational and interpersonal workspace alternative choices; and finally changes in choices made across the three units of analysis.

As shown in Figure 4.18 it was possible to verify that the majority of participants (56.2%) maintained their choices across the three levels in study. 36.1% chose differently between at least two of the three levels. Only 7.7% of participants had different choices for every one of the three levels studied.

Figure 4.18
Workspace Alternative Choice



Results indicate that a doctoral student is more likely to maintain his or her choice of workspace alternatives at the possible three comparison combinations than it is to change. The odds of change in choice when comparing individual and interpersonal choices are .58 to 1. The odds of change in choice when comparing individual and organizational choices are .54 to 1. The odds of change in choice when comparing interpersonal and organizational choices are .30 to 1. The overall odds of change in choices across the three levels studied are .78 to 1.

As with the workspace types portion of the study, this result was an indication of possible association between the choices of workspace alternatives made by participants as individuals, as part of their immediate workgroup and as part of their organizations. The association of choices was tested by the crosstabulation of the pair of levels of workspace alternative choices made by participants (Appendix C) and their respective Chi square and confidence level calculations (table 4.6).

Table 4.6
Organization Workspace Type Choice

Association tested	Chi square	Significance
Individual interpersonal	525.335	.000
Individual organizational	489.883	.000
Interpersonal organizational	771.298	.000

As it can be seen from table 4.6 significance levels of association based on the Chi square values are all smaller than .01. This result strongly indicates that there is a significant association between the workspace alternative choices made at the three

combinations of units of analysis studied. All associations were significant at a 99% confidence level.

4.5. Needs, Preferences and Current Situation Data Reduction

Data collected meets the basic criteria of sample size greater than 300 for performing a factor analysis. In addition to the qualitatively proposed variable grouping, two other groups of variables in the needs and preferences sections of the survey were identified through factor analysis. There were differences in the variable compositions of the identified factors. The factors remained constant between the needs and preferences.

4.5.1. Needs

As a first step in the factor analysis of the needs section of the survey it was necessary to evaluate the existence of significant levels of correlation between variables. A correlation matrix was generated to perform this evaluation (Appendix D). The determinant value, a test for multicollinearity, was also obtained. The initial determinant value did not meet the criteria of higher than a value of 0.00001 for the factor analysis. This was an indication that there were variables that did not significantly correlate with other variables and needed to be excluded.

As general criteria it was determined that variables that did not correlate significantly with at least ¾ of the remaining variables would be excluded from the factor analysis. Under this criterion four variables were excluded as indicated in appendix D. Excluded

variables were: Team or group work; Information exchange with coworkers; Interaction with individuals outside immediate workgroup; and Ability to work remotely.

A second correlation matrix with the seventeen remaining variables (Appendix D) was generated and a determinant value obtained was 0.002 that met the criteria for performing factor analysis. The correlation coefficient values in appendix D were all below 0.75. Correlation coefficients values greater than 0.9 indicate singularity problems in the data. In other words, correlation coefficients values greater than 0.9 indicate the possibility that two variables are measuring the same concept. The value obtained indicated that there were no highly correlated values thus eliminated the possibility of singularity in the data.

As indicated in table 4.7 the Kaiser-Meyer-Olkin (KMO) statistic, a measure of sampling adequacy, obtained for the data was 0.79. KMO values between 0.7 and 0.8 and are considered good indicators that patterns of correlation are relatively compact (Field, 2005). The value obtained indicates that factor analysis is appropriate for the data.

Also on table 4.7 Bartlett's test of sphericity indicates high significance reinforcing that factor analysis is appropriate for the data. Bartlett's test is a measure to indicate if all correlation coefficients are 0 or tend to 0. In such cases, the correlation coefficients tables are called identity tables, and not suitable for factor analysis.

Table 4.7
KMO and Bartlett's Test – Needs

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.790
Bartlett's Test of Sphericity	Approx. Chi-Square	2150.258
	df	136
	Sig.	.000

In table 4.8 the eigenvalues and the variance explained by each linear component are presented. Eigenvalues are vectors that represent the total variance explained by each linear component. The table presents values before and after extraction of factors. The criteria for extraction are eigenvalues greater than 1.0 and it is based on principal component analysis. As a result of extraction five factors with eigenvalues greater than 1.0 were identified from the data.

A critical output in the factor analysis is the table of communalities (table 4.9). Extraction based on Kaiser's criteria, as shown in table 4.8, is only accurate if average communalities for samples greater than 250 is greater than 0.6. Average communality obtained from the data was 0.64, thus extraction can be considered accurate.

Table 4.8
Total Variance Explained - Needs

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.841	28.478	28.478	4.841	28.478	28.478	3.033	17.841	17.841
2	1.916	11.273	39.751	1.916	11.273	39.751	2.398	14.104	31.945
3	1.659	9.757	49.508	1.659	9.757	49.508	1.875	11.028	42.973
4	1.316	7.740	57.248	1.316	7.740	57.248	1.820	10.704	53.677
5	1.164	6.845	64.093	1.164	6.845	64.093	1.771	10.416	64.093
6	.913	5.368	69.461						
7	.843	4.961	74.422						
8	.716	4.213	78.634						
9	.603	3.545	82.180						
10	.598	3.519	85.699						
11	.489	2.878	88.577						
12	.451	2.653	91.230						
13	.355	2.087	93.317						
14	.331	1.945	95.261						
15	.288	1.692	96.954						
16	.280	1.650	98.604						
17	.237	1.396	100.000						

Extraction Method: Principal Component Analysis.

Table 4.9
Communalities - Needs

Needs Variables	Initial	Extraction
Visual Privacy	1.000	.793
Conversational Privacy	1.000	.782
Amount of space	1.000	.578
Amount of work surface	1.000	.580
Amount of work storage	1.000	.664
Amount of personal storage	1.000	.536
Overall office noise	1.000	.457
Control over air quality	1.000	.737
Control over lighting	1.000	.773
Control over ambient temperature	1.000	.731
Overall office comfort	1.000	.579
Interaction with coworkers	1.000	.401
Ability to hold private/formal meetings	1.000	.776
Ability to hold informal meetings	1.000	.793
Work schedule flexibility	1.000	.526
Ability to use paperless processes	1.000	.557
Ability to make decisions about deliverables	1.000	.633

Extraction Method: Principal Component Analysis.

Finally the rotated component matrix on table 4.10 shows the variable loadings into each factor. Variable loadings greater than 0.4 are considered significant and are displayed in bold. Loadings with values less than 0.1 are not displayed. The results show that there are no cross-loading of variables into any of the factors extracted. It is also clearly possible to associate highly loading variables in each of the five factors extracted to common themes.

Factor 1 is significantly loaded by five variables associated to physical and environmental workspace issues. Factor 2 is significantly loaded by four variables associated to space workspace issues. Factor 3 is significantly loaded by three variables

associated to interaction workspace issues. Factor 4 is significantly loaded by four variables associated to autonomy workspace issues. And finally, factor 5 is significantly loaded by two variables associated to privacy workspace issues.

Table 4.10
Rotated Component Matrix(a) - Needs

Needs Variables	Component				
	1 Physical\ Environmental	2 Space	3 Interaction	4 Autonomy	5 Privacy
Control over lighting	**.859**	.110		.120	
Control over ambient temperature	**.847**				
Control over air quality	**.821**	.181		.130	.101
Overall office comfort	**.623**	.278	.162	.285	
Overall office noise	**.550**	.166			.350
Amount of work storage		**.789**	.136	.115	
Amount of space	.126	**.741**			.106
Amount of work surface	.101	**.721**		.199	
Amount of personal storage -Needs	.230	**.686**	.109		
Ability to hold informal meetings			**.860**	.175	.131
Ability to hold private/formal meetings		.105	**.845**	.100	.186
Interaction with coworkers	.116	.146	**.520**	.109	-.290
Ability to make decisions about deliverables	.120			**.775**	
Ability to use paperless processes	.132			**.718**	.125
Work schedule flexibility		.159	.211	**.669**	
Visual Privacy	.196			.160	**.852**
Conversational Privacy	.158		.155		**.851**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 6 iterations.

Seventeen variables of the original twenty one variables, associated with the needs section of the survey, were used in the factor analysis. Five factors were extracted and associated to real world constructs as explained above. This result indicates that the originally proposed variable grouping does not fully fit the data. Two additional variable groups have to be considered in the study of the effects of the indicated needs of participants on choices made. The additional groups were “Space” and “Privacy.”

4.5.2. Preferences

As in the previous section, a first step in the factor analysis of preferences section of the survey it was necessary to evaluate the existence of significant levels of correlation between variables. A correlation matrix was generated to perform this evaluation (Appendix D). The determinant value of 0.000036 was obtained and met the criteria of higher than a value of 0.00001 for the factor analysis.

As general criteria it was defined that variables that did not correlate significantly with at least ¾ of the remaining variables would be excluded from the factor analysis. Under this criterion no variables needed to be excluded.

The correlation coefficient values in appendix D were all bellow 0.8. Correlation coefficients values greater than 0.9 indicate singularity problems in the data. In other words, correlation coefficients values greater than 0.9 indicate the possibility that two variables are measuring the same event. The value obtained indicated that there were no highly correlated values thus eliminated the possibility of singularity in the data.

As indicated in table 4.11 the Kaiser-Meyer-Olkin (KMO) statistic, a measure of sampling adequacy, obtained for the data is of 0.82. KMO values between 0.8and 0.9 are considered very good indicators that patterns of correlation are relatively compact (Field, 2005). The value obtained indicates that factor analysis is appropriate for the data.

Also on table 4.11 Bartlett's test of sphericity indicates high significance reinforcing that factor analysis is appropriate for the data. Bartlett's test is a measure to indicate if all correlation coefficients are 0 or tend to 0, in which case would configure what is called an identity table, and not suitable for factor analysis.

Table 4.11
KMO and Bartlett's Test - Preferences

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.822
Bartlett's Test of Sphericity	Approx. Chi-Square	3603.155
	df	210
	Sig.	.000

In table 4.12 the eigenvalues and the variance explained by each linear component are presented. The table presents values before and after extraction of factors. The criteria for extraction are eigenvalues greater than 1.0 and it is based on principal component analysis. As a result of extraction five factors with eigenvalues greater than 1.0 were identified from the data.

Table 4.12
Total Variance Explained - Preferences

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.721	27.243	27.243	5.721	27.243	27.243	3.702	17.626	17.626
2	2.963	14.112	41.355	2.963	14.112	41.355	2.975	14.166	31.792
3	2.008	9.563	50.919	2.008	9.563	50.919	2.716	12.931	44.723
4	1.659	7.900	58.819	1.659	7.900	58.819	2.467	11.745	56.468
5	1.360	6.478	65.296	1.360	6.478	65.296	1.854	8.828	65.296
6	.981	4.671	69.967						
7	.876	4.171	74.138						
8	.680	3.238	77.376						
9	.649	3.090	80.466						
10	.580	2.763	83.229						
11	.516	2.457	85.686						
12	.453	2.157	87.843						
13	.410	1.954	89.797						
14	.370	1.763	91.560						
15	.338	1.609	93.169						
16	.279	1.328	94.497						
17	.269	1.282	95.779						
18	.251	1.195	96.974						
19	.233	1.109	98.083						
20	.207	.986	99.069						
21	.195	.931	100.000						

Extraction Method: Principal Component Analysis.

A critical output in the factor analysis is the table of communalities (table 4.13). Extraction based on Kaiser's criteria, as shown in table 4.12, is only accurate if average communalities for samples greater than 250 is greater than 0.6. Average communality obtained from the data was 0.65, thus extraction can be considered accurate.

Finally the rotated component matrix on table 4.14 shows the variable loadings into each factor. Variable loadings greater than 0.4 are considered significant and are displayed in bold. Loadings with values less than 0.1 are not displayed. The results show that there are no cross-loading of variables into any of the factors extracted. It is also clearly possible to associate highly loading variables in each of the five factors extracted to common themes.

Factor 1 is significantly loaded by six variables associated to interaction workspace issues. Factor 2 is significantly loaded by five variables associated to physical and environmental workspace issues. Factor 3 is significantly loaded by four variables associated to space workspace issues. Factor 4 is significantly loaded by four variables associated to autonomy workspace issues. And finally, factor 5 is significantly loaded by two variables associated to privacy workspace issues.

Table 4.13
Communalities - Preferences

Preferences Variables	Initial	Extraction
Visual Privacy	1.000	.685
Conversational Privacy	1.000	.801
Amount of space	1.000	.756
Amount of work surface	1.000	.701
Amount of work storage	1.000	.709
Amount of personal storage	1.000	.550
Overall office noise	1.000	.389
Control over air quality	1.000	.742
Control over lighting	1.000	.773
Control over ambient temperature	1.000	.714
Overall office comfort	1.000	.404
Interaction with coworkers	1.000	.722
Information exchange with coworkers	1.000	.712
Team or group work	1.000	.780
Interaction with individuals outside immediate workgroup	1.000	.626
Ability to hold private/formal meetings	1.000	.632
Ability to hold informal meetings	1.000	.665
Work schedule flexibility	1.000	.522
Ability to work remotely	1.000	.667
Ability to use paperless processes	1.000	.647
Ability to make decisions about deliverables	1.000	.517

Extraction Method: Principal Component Analysis.

All of the original twenty one variables, associated with the preferences section of the survey, were used in the factor analysis. Five factors were extracted and associated to real world constructs as explained above. This result indicates that the originally proposed variable grouping does not fully fit the data. Two additional variable groups have to be considered in the study of the effects of the indicated needs of participants on choices made. Variables that loaded into the five factors for the need section loaded similar factors in the preferences section of the survey.

Table 4.14
Rotated Component Matrix(a) - Preferences

Preferences Variables	Component				
	1 Interaction	2 Physical\ Environmental	3 Space	4 Autonomy	5 Privacy
Team or group work	**.870**				-.104
Interaction with coworkers	**.823**		.155		-.123
Information exchange with coworkers	**.822**		.175		
Interaction with individuals outside immediate workgroup	**.769**	.147		.111	
Ability to hold informal meetings	**.647**			.313	.381
Ability to hold private/formal meetings	**.637**			.250	.398
Control over lighting		**.856**		.179	
Control over air quality		**.838**	.104	.128	
Control over ambient temperature		**.831**			.109
Overall office noise		**.535**	.175		.258
Overall office comfort	.166	**.486**	.246	.244	.141
Amount of space			**.830**		.227
Amount of work surface			**.814**		.188
Amount of work storage	.139	.129	**.805**	.157	
Amount of personal storage	.138	.212	**.683**	.111	
Ability to work remotely		.170		**.790**	
Ability to use paperless processes	.131	.187	.122	**.761**	
Work schedule flexibility	.105		.111	**.686**	.163
Ability to make decisions about deliverables	.241	.109		**.665**	
Conversational Privacy		.249	.172	.106	**.836**
Visual Privacy		.273	.123		**.768**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 5 iterations.

4.5.3. Current Situation

As in the previous sections, it was necessary to evaluate the existence of significant levels of correlation between variables. A correlation matrix was generated to perform this evaluation (Appendix D). The determinant value of 0.00000144 was obtained and did not meet the criteria of higher than a value of 0.00001 for the factor analysis. This was an indication that there were variables that either did not significantly correlate with other variables or that their correlation coefficients were too high and needed to be excluded.

As general criteria, it was decided that variables that did not correlate significantly with at least ¾ of the remaining variables would be excluded from the factor analysis. Under this criterion no variables were excluded. Analysis of the correlation coefficients indicated that two pair of variables had values close to 0.9, as shown in appendix D, indicating the possibility of singularity. A selection was made and two variables were excluded. The excluded variables were: Information exchange with coworkers; and Amount of work surface.

A second correlation matrix with the nineteen remaining variables (Appendix D) was generated and the determinant value obtained was 0.0000346 and met the criteria for performing factor analysis. The correlation coefficient values in appendix D were all bellow 0.8. The new values obtained indicated that there were no highly correlated values, and thus eliminated the possibility of singularity in the data.

Kaiser-Meyer-Olkin (KMO) statistics obtained for the data was 0.853 (Table 4.15). Also on table 4.15 Bartlett's test of sphericity indicates high significance. The results obtained indicate that factor analysis is appropriate for the data.

Table 4.15
KMO and Bartlett's Test – Current Situation

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.853
Bartlett's Test of Sphericity	Approx. Chi-Square	3665.666
	df	171
	Sig.	.000

In table 4.16 the eigenvalues and the variance explained by each linear component are presented. Eigenvalues are vectors that represent the total variance explained by each linear component. The table presents values before and after extraction of factors with eigenvalues greater than 1.0. Similar to the needs and preferences sections of the survey five factors were identified from the data.

A critical output in the factor analysis is the table of communalities (table 4.17). Extraction based on Kaiser's criteria, as shown in table 4.16, is only accurate if average communalities for samples greater than 250 is greater than 0.6. Average communality obtained from the data was 0.70, thus extraction can be considered accurate.

Table 4.16
Total Variance Explained – Current Situation

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.721	27.243	27.243	5.721	27.243	27.243	3.702	17.626	17.626
2	2.963	14.112	41.355	2.963	14.112	41.355	2.975	14.166	31.792
3	2.008	9.563	50.919	2.008	9.563	50.919	2.716	12.931	44.723
4	1.659	7.900	58.819	1.659	7.900	58.819	2.467	11.745	56.468
5	1.360	6.478	65.296	1.360	6.478	65.296	1.854	8.828	65.296
6	.981	4.671	69.967						
7	.876	4.171	74.138						
8	.680	3.238	77.376						
9	.649	3.090	80.466						
10	.580	2.763	83.229						
11	.516	2.457	85.686						
12	.453	2.157	87.843						
13	.410	1.954	89.797						
14	.370	1.763	91.560						
15	.338	1.609	93.169						
16	.279	1.328	94.497						
17	.269	1.282	95.779						
18	.251	1.195	96.974						
19	.233	1.109	98.083						
20	.207	.986	99.069						
21	.195	.931	100.000						

Extraction Method: Principal Component Analysis.

Table 4.17
Communalities – Current Situation

Current Situation Variables	Initial	Extraction
Visual Privacy	1.000	.808
Conversational Privacy	1.000	.834
Amount of space	1.000	.766
Amount of work storage	1.000	.820
Amount of personal storage	1.000	.792
Overall office noise	1.000	.449
Control over air quality	1.000	.778
Control over lighting	1.000	.575
Control over ambient temperature	1.000	.790
Overall office comfort	1.000	.631
Interaction with coworkers	1.000	.734
Team or group work	1.000	.773
Interaction with individuals outside immediate workgroup	1.000	.645
Ability to hold private/formal meetings	1.000	.659
Ability to hold informal meetings	1.000	.687
Work schedule flexibility	1.000	.612
Ability to work remotely	1.000	.717
Ability to use paperless processes	1.000	.602
Ability to make decisions about deliverables	1.000	.631

Extraction Method: Principal Component Analysis.

Finally the rotated component matrix on table 4.18 shows the variable loadings into each factor. Variable loadings greater than 0.4 are considered significant and are displayed in bold. Loadings with values less than 0.1 are not displayed. "Overall office comfort" was the only variable found to significantly load into two of the factors extracted simultaneously. The same themes used in the need and preferences sections can be associated to the five factors extracted in this factor analysis.

Table 4.18
Rotated Component Matrix(a) – Current Situation

Current	Component				
	1 Interaction	2 Space	3 Physical\ Environmental	4 Autonomy	5 Privacy
Team or group work	**.855**	.144	.112		
Interaction with coworkers	**.823**	.150	.125		
Interaction with individuals outside immediate workgroup	**.779**			.164	
Ability to hold informal meetings	**.762**	.184		.158	.209
Ability to hold private/formal meetings	**.675**	.152	.129	.181	.362
Amount of work storage	.107	**.871**	.127	.160	
Amount of personal storage	.163	**.857**	.108	.103	
Amount of space	.228	**.774**	.101		.318
Control over ambient temperature			**.871**	.125	
Control over air quality			**.859**	.132	.107
Control over lighting	.158	.140	**.674**		.258
Overall office comfort	.318	**.488**	**.490**		.225
Overall office noise	.117	.326	**.426**	.206	.324
Ability to work remotely	.221			**.787**	.216
Work schedule flexibility		.191		**.751**	
Ability to make decisions about deliverables		.108	.282	**.730**	
Ability to use paperless processes	.355			**.653**	.210
Visual Privacy		.220	.198	.109	**.842**
Conversational Privacy	.120	.205	.277	.108	**.830**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 6 iterations.

Factor 1 is significantly loaded by five variables associated to interaction workspace issues. Factor 2 is significantly loaded by three variables associated to space workspace issues. Factor 3 is significantly loaded by five variables associated to physical and environmental workspace issues. Factor 4 is significantly loaded by four variables associated to autonomy workspace issues. And finally, factor 5 is significantly loaded by two variables associated to privacy workspace issues. Nineteen of the original twenty one variables, associated with the preferences section of the survey, were used in the factor analysis.

4.5.4. Factor Analysis Summary

In summary results of factor analysis conducted on three sections of the survey indicate the existence of the same five common factors in each of the sections. Variable loadings into each of the factors identified across the sections were similar. These loadings are summarized in table 4.19.

The results of the factor analysis indicate that the originally proposed variable grouping based on the literature review did not fully explain the data obtained in this research. Two additional variable groups were considered in the study of the effects of the indicated needs of participants on choices made. The additional groups were “Space” and “Privacy.” The use of factor analysis allowed for significant data reduction, in the form of score computations. Thus, it also simplified the remainder of the statistical analysis of the research.

Table 4.19
Significant Loading Summary Matrix

Variables	Needs	Preferences	Current	Factor
Team or group work	**No**	Yes	Yes	Interaction
Interaction with coworkers	Yes	Yes	Yes	
Information exchange with coworkers	**No**	Yes	**No**	
Interaction with individuals outside immediate workgroup	**No**	Yes	Yes	
Ability to hold informal meetings	Yes	Yes	Yes	
Ability to hold private/formal meetings	Yes	Yes	Yes	
Control over lighting	Yes	Yes	Yes	Physical Environmental
Control over air quality	Yes	Yes	Yes	
Control over ambient temperature	Yes	Yes	Yes	
Overall office noise	Yes	Yes	Yes	
Overall office comfort	Yes	Yes	Yes*	
Amount of space	Yes	Yes	Yes	Space
Amount of work surface	Yes	Yes	**No**	
Amount of work storage	Yes	Yes	Yes	
Amount of personal storage	Yes	Yes	Yes	
Ability to work remotely	**No**	Yes	Yes	Autonomy
Ability to use paperless processes	Yes	Yes	Yes	
Work schedule flexibility	Yes	Yes	Yes	
Ability to make decisions about deliverables	Yes	Yes	Yes	
Conversational Privacy	Yes	Yes	Yes	Privacy
Visual Privacy	Yes	Yes	Yes	

*Cross-loads with space factors

4.6. Scores Computation and Analysis

To study the effect that different variables have on the workspace type and alternatives choices made by participants data reduction scores were computed. Based on the factor analysis results two sets of scores were computed for each of the five factors identified for the different sections of the survey.

The first score, called absolute score, consisted of the average of the responses given by any participant per variables loading each of the factors. The second score was a binary

score based on the mean of the absolute score, called relative score. The binary score divided the resulting absolute scores in to high and low categories.

Kolmogorov-Smirnov tests of normality (Ott & Longnecker, 2001) were performed on the resulting absolute scores. The results had significance levels smaller than .001 for all of the scores. This indicated that the data does not conform to the normal distribution curve. Transformations of the scores were attempted and the Kolmogorov-Smirnov tests of the transformations also yield significance levels smaller than .001 for all of the scores. These results eliminated the possibility of using parametric statistics for the remainder of the analysis process, as normality is a basic assumption of these statistical procedures. The alternative to these procedures in such cases is the use of nonparametric statistics.

Nonparametric statistics are appropriate and commonly used in social and behavioral sciences as they make no assumptions about the distribution (Gibbons, 1993). In research using Likert scales, such as in the case of the workspace survey developed for this study, the use of nonparametric statistical procedures are strongly recommended due to the scalar nature of the data (Gibbons, 1993). It is also argued that nonparametric statistics are more robust procedures than the commonly used parametric statistics and can be used to validate parametric statistical procedure findings (Sprent & Smeeton, 2007). Nonparametric statistics equivalent to the originally planned parametric statistical procedures were identified and used for this portion of the survey data analysis.

4.6.1. Need and Preferences Nonparametric Score Comparisons

Scores for the five factors identified in the needs and preferences sections of the survey were compared using the Wilcoxon signed ranks test (Ott & Longnecker, 2001). The results shown in table 4.20 indicate that there are no significant differences between the scores for needs and the scores for preferences in interaction, environmental, space, and autonomy factors. Only the factor associated to privacy had a significance level smaller than .005.

The r value, a test of effect size for significant differences, of the comparison between needs and preferences privacy factor was of -0.2181. This value indicated that the effect size according to the scale in table 4.21 proposed by Cohen (1988) is a small value. This result challenges the assumption of semantic differences between the concept of needs and the concept of preferences used in the development of the survey instrument. These results also indicated the necessity of testing the levels of correlation between twenty one variables used in the needs and preferences sections of the workspace survey.

Table 4.20
Wilcoxon Signed Ranks Test Statistic

Scores	Z	Asymp. Sig. (2-tailed)	r
Interaction – Preferences Interaction – Needs	-1.441(a)	.150	-0.053
Environmental – Preferences Environmental – Needs	-.781(a)	.435	-0.029
Space –P references Space – Needs	-1.238(a)	.216	-0.047
Autonomy – Preferences Autonomy – Needs	-.787(b)	.431	-0.029
Score Privacy – Preferences Score Privacy - Needs	-5.868(a)	. 4.39E-09	-0.218

a Based on positive ranks - b Based on negative ranks.

Table 4.21
"r" Values Scale by Cohen (1988)

Effect Size	r values
Small	r=.10 to .29
Medium	r=.30 to .49
Large	r=.50 to 1.0

4.6.1.1. Needs and Preferences Differences Exploration

Kolmogorov-Smirnov tests of normality were conducted on the twenty one variables in each of the needs and preferences sections of the survey. As with the factor scores, results had significance levels smaller than .001 for all of the variables. This indicated that the data had a non-normal distribution. Transformations of the variables were attempted and the Kolmogorov-Smirnov tests of the transformations also yield significance levels smaller than .001 for all of the variables. These results indicated the need to use nonparametric statistics for the study of the needs and preferences variables.

The Spearman non-parametric correlation test of paired needs and preferences variables are summarized in table 4.22. Results indicated that all pairs of variables were significantly correlated and had significance values smaller than .01. The correlation coefficients indicated a large positive effect size (J. Cohen, 1988).

Table 4.22
Need and Preferences Correlation Summary

Variable	correlation coefficient	Sig. (2-tailed)	N	Significant
Visual Privacy	0.63	.000	370	Yes
Conversational Privacy	0.59	.000	362	Yes
Amount of space	0.53	.000	366	Yes
Amount of work surface	0.56	.000	364	Yes
Amount of work storage	0.57	.000	366	Yes
Amount of personal storage	0.65	.000	365	Yes
Overall office noise	0.71	.000	369	Yes
Control over air quality	0.69	.000	367	Yes
Control over lighting	0.65	.000	370	Yes
Control over ambient temperature	0.67	.000	369	Yes
Overall office comfort	0.56	.000	368	Yes
Interaction with coworkers	0.66	.000	367	Yes
Information exchange with coworkers	0.53	.000	370	Yes
Team or group work – Preferences	0.69	.000	369	Yes
Interaction with individuals outside immediate workgroup	0.65	.000	366	Yes
Ability to hold private/formal meetings	0.67	.000	367	Yes
Ability to hold informal meetings	0.63	.000	370	Yes
Work schedule flexibility	0.54	.000	369	Yes
Ability to work remotely	0.67	.000	367	Yes
Ability to use paperless processes	0.59	.000	369	Yes
Ability to make decisions about deliverables	0.56	.000	367	Yes

Correlation is significant at the 0.01 level (2-tailed).

As a step further in the exploration of the results test of differences between the responses were needed. The twenty one pairs of variables of the needs and preferences sections of the survey were compared using the Wilcoxon signed ranks test. The results shown in table 4.23 indicate that there are no significant differences in the responses on thirteen out of the twenty one pairs studied. Effect sizes for the eight significantly different variables indicated small values (J. Cohen, 1988).

Table 4.23
Paired Needs and Preferences Test Statistic

Variables	Z	Sig. (2-tailed)	N	r	Significant
Visual Privacy	-4.44	0.000	370	-0.163	Yes
Conversational Privacy	-5.03	0.000	362	-0.187	Yes
Amount of space	-1.49	0.137	366	-0.055	No
Amount of work surface	-2.64	0.008	364	-0.098	Yes
Amount of work storage	-1.15	0.250	366	-0.042	No
Amount of personal storage	-1.60	0.109	365	-0.059	No
Overall office noise	-0.26	0.794	369	-0.010	No
Control over air quality	-1.55	0.121	367	-0.057	No
Control over lighting	-0.32	0.750	370	-0.012	No
Control over ambient temperature	-2.26	0.024	369	-0.083	Yes
Overall office comfort	-2.88	0.004	368	-0.106	Yes
Interaction with coworkers	-0.48	0.629	367	-0.018	No
Information exchange with coworkers	-2.02	0.044	370	-0.074	Yes
Team or group work	-0.01	0.996	369	0.000	No
Interaction with individuals outside immediate workgroup	-4.53	0.000	366	-0.167	Yes
Ability to hold private/formal meetings	-1.78	0.075	367	-0.066	No
Ability to hold informal meetings	-3.28	0.001	370	-0.121	Yes
Work schedule flexibility	-0.09	0.928	369	-0.003	No
Ability to work remotely	-1.56	0.119	367	-0.058	No
Ability to use paperless processes	-0.21	0.835	369	-0.008	No
Ability to make decisions about deliverables	-1.85	0.064	367	-0.068	No

a. Based on positive ranks. b. Based on negative ranks. c. Wilcoxon Signed Ranks Test

4.6.1.2. Summary of Needs and Preferences Nonparametric Score Comparison

In summary, results from the needs and preferences exploration confirmed the indications from the nonparametric needs and preferences factors scores comparison. High positive correlations on all of the pairs of needs and preferences variables analyzed reinforced questions about the existence of differences between the declared preferences and declared needs. Finally the results of the Wilcoxon signed ranks test for these pairs of variables show that the majority of the variables on the needs and preferences sections of the survey have no significant differences. Furthermore, all of the pairs of variables that had significant differences also had effect sizes that are considered small.

These results indicated that the assumption of a semantic differentiation between needs and preferences for the purposes of the development of the survey instrument was not evident in the data. Considering that one of the purposes of the study was to identify needs and or preference factors that affect workspace type and alternative choices, these results indicate that there is not enough distinction in the data to justify the consideration of both sections of the survey. At this point it was necessary to decide on the elimination of responses from either the needs or preferences sections of the survey.

Given that the factor analysis of the preferences yield five factors that were loaded by all of the originally selected variables; and that the needs factor analysis resulted in the same five factors loaded with seventeen out of the twenty one original variables; the

preferences portion of the survey would allow for a more complete analysis and was selected for the final portion of the study.

4.6.2. Preference Scores Analysis

Scores for the five factors resultant from the preferences section of the survey were converted to binary categorical variables. Variables were collapsed into high and low scores based on the median. The median was selected as the reference for variable collapsing due to the results from the test of normality in the previous section. Results indicated that the five factors did not have a normal distribution; therefore the mean was not considered an appropriate measure.

Relative to the median high and low scores were cross tabulated with workspace type and workspace alternatives choices made. In sections 4.4 and 4.5 it was found that there was an association between workspace type and workspace alternative choices at the individual interpersonal and organizational levels. Given this result, this portion of the analysis used only the declared workspace type and workspace alternative choices at the individual level. Results from the crosstabulations are discussed below.

4.6.2.1. Individual Workspace Type and Relative Scores

Each of the five factors' relative scores was cross tabulated with the choices of workspace types indicated in the survey. It was found that three of the five relative scores (interaction, environmental and privacy) are associated with the workspace type choices.

The difference in percentages, as seen in figure 4.19, within the workspace type choices for the factor interaction was an indicator of the association between factor and choice. Through crosstabulation of these choices and relative high and low interaction scores (Table 4.24) it was possible to obtain the Pearson's Chi square measure of association. The Chi square result was .001 (Table 4.25). This result was less than .05 which indicated that it can be stated that the score for interaction factors is significantly associated with the choices of workspace type.

Figure 4.19
Workspace Type and Interaction Relative Scores

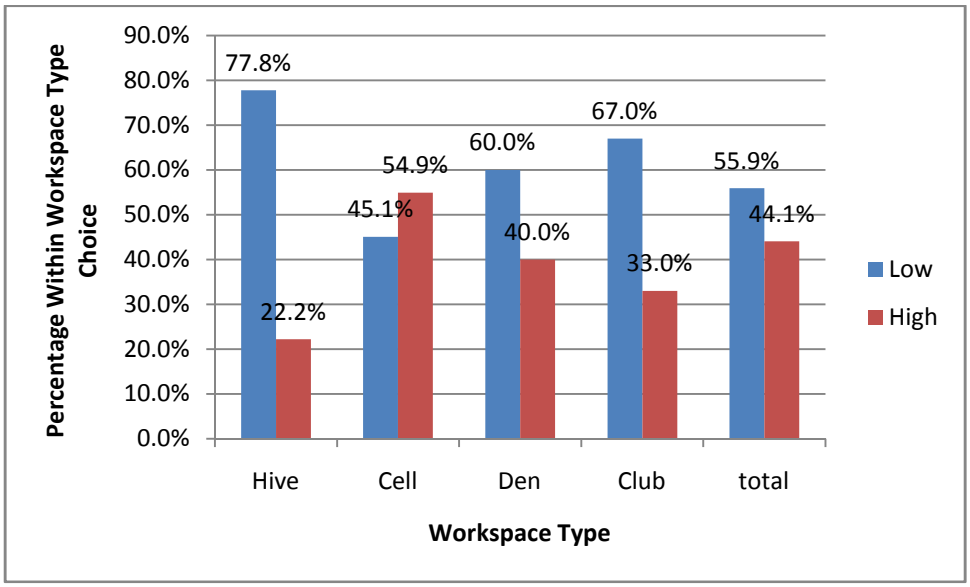


Table 4.24
Workspace Type and Interaction Relative Scores Crosstab

			Relative to Median Factor Interaction		
			Low	High	Total
Workspace Type Choice - INDIVIDUAL	Hive	Count	14	4	18
		% within Workspace Type Choice - INDIVIDUAL	77.8%	22.2%	100.0%
		% within Relative to Median Interaction	6.9%	2.5%	4.9%
	Cell	Count	78	95	173
		% within Workspace Type Choice - INDIVIDUAL	45.1%	54.9%	100.0%
		% within Relative to Median Interaction	38.2%	59.0%	47.4%
	Den	Count	39	26	65
		% within Workspace Type Choice - INDIVIDUAL	60.0%	40.0%	100.0%
		% within Relative to Median Interaction	19.1%	16.1%	17.8%
	Club	Count	73	36	109
		% within Workspace Type Choice - INDIVIDUAL	67.0%	33.0%	100.0%
		% within Relative to Median Interaction	35.8%	22.4%	29.9%
Total		Count	204	161	365
		% within Workspace Type Choice - INDIVIDUAL	55.9%	44.1%	100.0%
		% within Relative to Median Interaction	100.0%	100.0%	100.0%

Table 4.25
Workspace Type and Interaction Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.564(a)	3	.001
Likelihood Ratio	17.910	3	.000
Linear-by-Linear Association	6.490	1	.011
N of Valid Cases	365		

Similar to the factor interaction, among the physical/environmental factors, there were differences in percentage within the workspace type choices, as seen in figure 4.20. Through crosstabulation of these choices and relative high and low physical/environmental scores (Table 4.26) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.27) result was .033. This result is less than .05 and therefore it can be stated that the score for physical/environmental factors is significantly associated with the choices of workspace type.

Figure 4.20
Workspace Type and Physical/Environmental Relative Scores

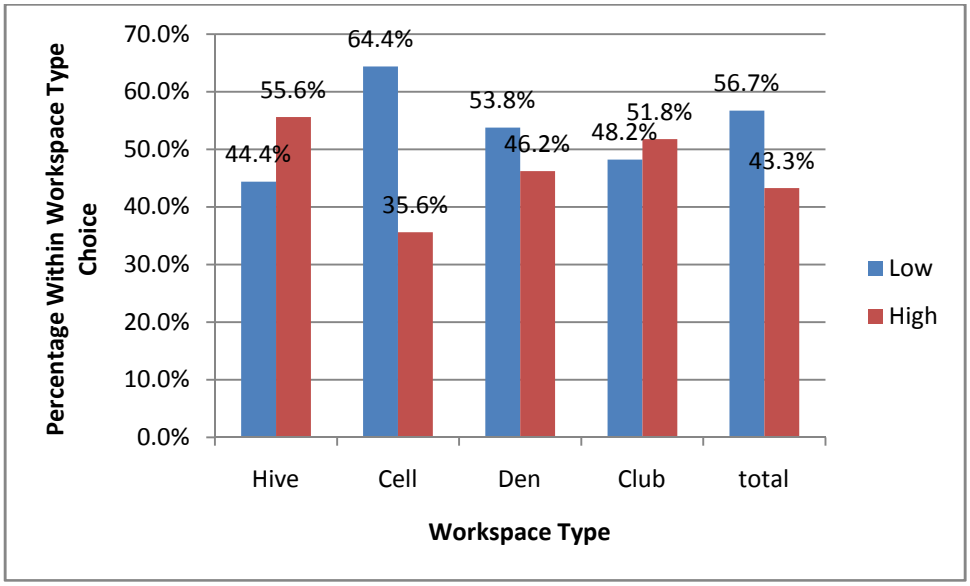


Table 4.26
Workspace Type and Physical/Environmental Relative Scores Crosstab

			Relative to Median Physical/Environmental		
			Low	High	Total
Workspace Type Choice - INDIVIDUAL	Hive	Count	8	10	18
		% within Workspace Type Choice - INDIVIDUAL	44.4%	55.6%	100.0%
		% within Relative to Median Environmental	3.8%	6.3%	4.9%
	Cell	Count	112	62	174
		% within Workspace Type Choice - INDIVIDUAL	64.4%	35.6%	100.0%
		% within Relative to Median Environmental	53.8%	39.0%	47.4%
	Den	Count	35	30	65
		% within Workspace Type Choice - INDIVIDUAL	53.8%	46.2%	100.0%
		% within Relative to Median Environmental	16.8%	18.9%	17.7%
	Club	Count	53	57	110
		% within Workspace Type Choice - INDIVIDUAL	48.2%	51.8%	100.0%
		% within Relative to Median Environmental	25.5%	35.8%	30.0%
Total		Count	208	159	367
		% within Workspace Type Choice - INDIVIDUAL	56.7%	43.3%	100.0%
		% within Relative to Median Environmental	100.0%	100.0%	100.0%

Table 4.27
Workspace Type and Physical\Environmental Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.734(a)	3	.033
Likelihood Ratio	8.764	3	.033
Linear-by-Linear Association	4.148	1	.042
N of Valid Cases	367		

In the case of the space factors, the percentages within the workspace type choices remained fairly constant across all workspace type choices (figure 4.21). This was viewed as an indicator that there was no association between factor and choice. Through crosstabulation of these choices and relative high and low space scores (Table 4.28) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.29) result was .750. This result is higher than .05 and indicated that it can be stated that the score for space factors is not significantly associated with the choices of workspace type.

Figure 4.21
Workspace Type and Space Relative Scores

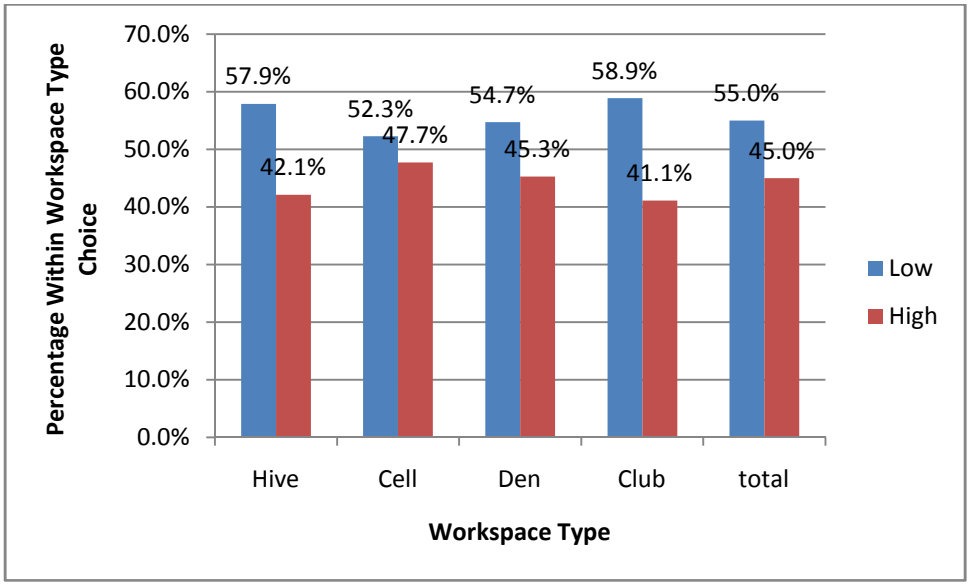


Table 4.28
Workspace Type and Space Relative Scores Crosstab

			Relative to Median Space		
			Low	High	Total
Workspace Type Choice - INDIVIDUAL	Hive	Count	11	8	19
		% within Workspace Type Choice - INDIVIDUAL	57.9%	42.1%	100.0%
		% within Relative to Median Space	5.5%	4.9%	5.2%
	Cell	Count	90	82	172
		% within Workspace Type Choice - INDIVIDUAL	52.3%	47.7%	100.0%
		% within Relative to Median Space	45.2%	50.3%	47.5%
	Den	Count	35	29	64
		% within Workspace Type Choice - INDIVIDUAL	54.7%	45.3%	100.0%
		% within Relative to Median Space	17.6%	17.8%	17.7%
	Club	Count	63	44	107
		% within Workspace Type Choice - INDIVIDUAL	58.9%	41.1%	100.0%
		% within Relative to Median Space	31.7%	27.0%	29.6%
Total		Count	199	163	362
		% within Workspace Type Choice - INDIVIDUAL	55.0%	45.0%	100.0%
		% within Relative to Median Space	100.0%	100.0%	100.0%

Table 4.29
Workspace Type and Space Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.214(a)	3	.750
Likelihood Ratio	1.217	3	.749
Linear-by-Linear Association	.719	1	.397
N of Valid Cases	362		

In the case of the autonomy factors, the percentages within the workspace type choices also remained fairly constant across all workspace type choices (figure 4.22). This was viewed as an indicator that there was no association between factor and choice. Through crosstabulation of these choices and relative high and low autonomy scores (Table 4.30) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.31) result was .266. This result is higher than .05 and indicated that it can be stated that the score for autonomy factors is not significantly associated with the choices of workspace type.

Figure 4.22
Workspace Type and Autonomy Relative Scores

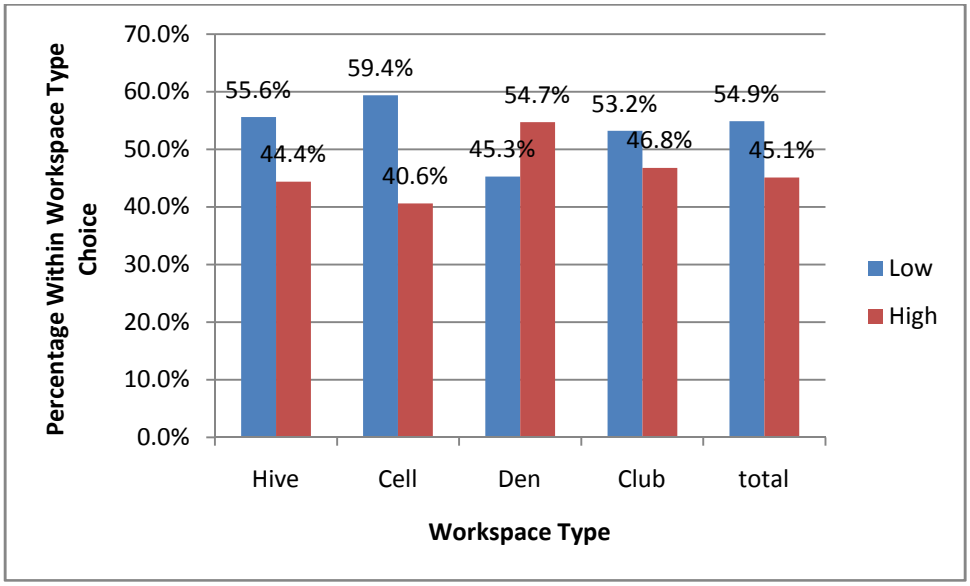


Table 4.30
Workspace Type and Autonomy Relative Scores Crosstab

			Relative to Median Autonomy		
			Low	High	Total
Workspace Type Choice - INDIVIDUAL	Hive	Count	10	8	18
		% within Workspace Type Choice - INDIVIDUAL	55.6%	44.4%	100.0%
		% within Relative to Median Autonomy	5.0%	4.8%	4.9%
	Cell	Count	104	71	175
		% within Workspace Type Choice - INDIVIDUAL	59.4%	40.6%	100.0%
		% within Relative to Median Autonomy	51.7%	43.0%	47.8%
	Den	Count	29	35	64
		% within Workspace Type Choice - INDIVIDUAL	45.3%	54.7%	100.0%
		% within Relative to Median Autonomy	14.4%	21.2%	17.5%
	Club	Count	58	51	109
		% within Workspace Type Choice - INDIVIDUAL	53.2%	46.8%	100.0%
		% within Relative to Median Autonomy	28.9%	30.9%	29.8%
Total		Count	201	165	366
		% within Workspace Type Choice - INDIVIDUAL	54.9%	45.1%	100.0%
		% within Relative to Median Autonomy	100.0%	100.0%	100.0%

Table 4.31
Workspace Type and Autonomy Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.954(a)	3	.266
Likelihood Ratio	3.949	3	.267
Linear-by-Linear Association	1.226	1	.268
N of Valid Cases	366		

Finally, in the case of the privacy factors, there were percentage differences within the workspace type choices (figure 4.23). This was viewed as an indicator that there was an association between factor and choice. Through crosstabulation of these choices and relative high and low privacy scores (Table 4.32) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.33) result was .000. This result is less than .05 and indicated that it can be stated that the score for privacy factors is significantly associated with the choices of workspace type.

Figure 4.23
Workspace Type and Privacy Relative Scores

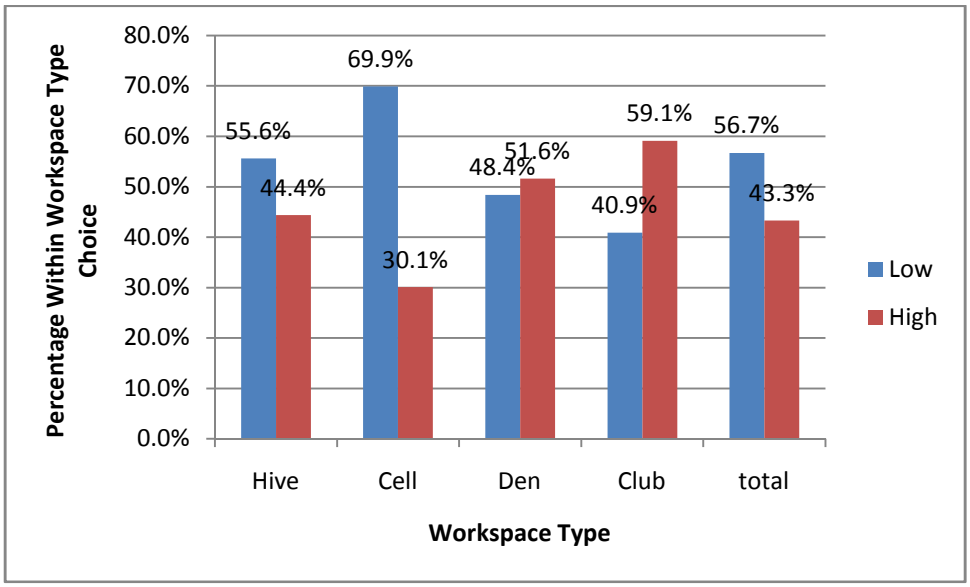


Table 4.32
Workspace Type and Privacy Relative Scores Crosstab

			Relative to Median Privacy		
			Low	High	Total
Workspace Type Choice - INDIVIDUAL	Hive	Count	10	8	18
		% within Workspace Type Choice - INDIVIDUAL	55.6%	44.4%	100.0%
		% within Relative to Median Privacy	4.8%	5.1%	4.9%
	Cell	Count	121	52	173
		% within Workspace Type Choice - INDIVIDUAL	69.9%	30.1%	100.0%
		% within Relative to Median Privacy	58.5%	32.9%	47.4%
	Den	Count	31	33	64
		% within Workspace Type Choice - INDIVIDUAL	48.4%	51.6%	100.0%
		% within Relative to Median Privacy	15.0%	20.9%	17.5%
	Club	Count	45	65	110
		% within Workspace Type Choice - INDIVIDUAL	40.9%	59.1%	100.0%
		% within Relative to Median Privacy	21.7%	41.1%	30.1%
Total		Count	207	158	365
		% within Workspace Type Choice - INDIVIDUAL	56.7%	43.3%	100.0%
		% within Relative to Median Privacy	100.0%	100.0%	100.0%

Table 4.33
Workspace Type and Privacy Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	25.320(a)	3	.000
Likelihood Ratio	25.645	3	.000
Linear-by-Linear Association	19.663	1	.000
N of Valid Cases	365		

4.6.2.2. Individual Workspace Alternatives and Relative Scores

As with the workspace types, each relative score for the five factors was crosstabulated with the choices of workspace alternatives indicated in the survey. It was found that two of the five relative scores, autonomy and privacy, are associated to the workspace alternative choices.

The similarity in percentages within the workspace alternative choices for the factor interaction was an indicator that factor and choice were not associated (figure 4.24). Through crosstabulation of these choices and relative high and low interaction scores (Table 4.34) it was possible to obtain the Pearson's Chi square measure of association. Pearson's Chi square (Table 4.35) result was .098. This result was higher than .05 which indicated that it can be stated that the score for interaction factors is not significantly associated with the choices of workspace alternatives.

Table 4.34
Workspace Alternative and Interaction Relative Scores Crosstab

			Relative to Median Interaction		Total
			Low	High	Low
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space (Alternative 1)	Count	57	66	123
		% within Workspace Alternative Choice	46.3%	53.7%	100.0%
		% within Relative to Median Interaction	28.2%	41.5%	34.1%
	Individual Partitioned Space (Alternative 2)	Count	59	38	97
		% within Workspace Alternative Choice	60.8%	39.2%	100.0%
		% within Relative to Median Interaction	29.2%	23.9%	26.9%
	Assigend Shared Partitioned Space (Alternative 3)	Count	34	23	57
		% within Workspace Alternative Choice	59.6%	40.4%	100.0%
		% within Relative to Median Interaction	16.8%	14.5%	15.8%
	Unassigned Shared Partitioned Space (Alternative 4)	Count	24	18	42
		% within Workspace Alternative Choice	57.1%	42.9%	100.0%
		% within Relative to Median Interaction	11.9%	11.3%	11.6%
	Mobile Work Environment (Alternative 5)	Count	28	14	42
		% within Workspace Alternative Choice	66.7%	33.3%	100.0%
		% within Relative to Median Interaction	13.9%	8.8%	11.6%
Total		Count	202	159	361
		% within Workspace Alternative Choice	56.0%	44.0%	100.0%
		% within Relative to Median Interaction	100.0%	100.0%	100.0%

Figure 4.24
Workspace Alternative and Interaction Relative Scores

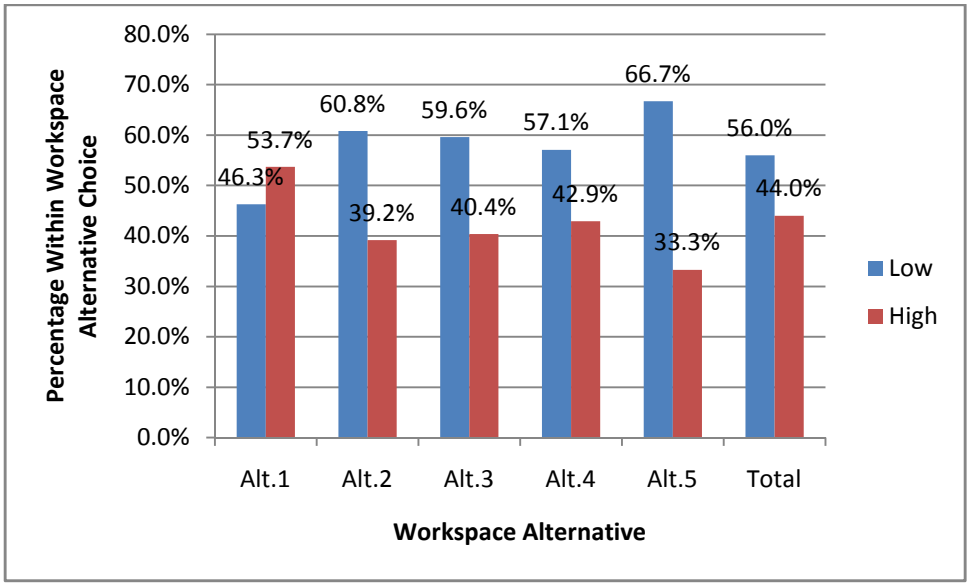


Table 4.35
Workspace Alternative and Interaction Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.841(a)	4	.098
Likelihood Ratio	7.861	4	.097
Linear-by-Linear Association	4.890	1	.027
N of Valid Cases	361		

Again, similarity in percentages within the workspace alternative choices for the physical/environmental factors was an indicator that factor and choice were not associated (figure 4.25). Through crosstabulation of these choices and relative high and low physical/environmental scores (Table 4.37) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.36) result was

.407. This result was higher than .05 which indicated that it can be stated that the score for environmental factors is not significantly associated with the choices of workspace alternative.

Figure 4.25
Workspace Alternative and Physical/Environmental Relative Scores

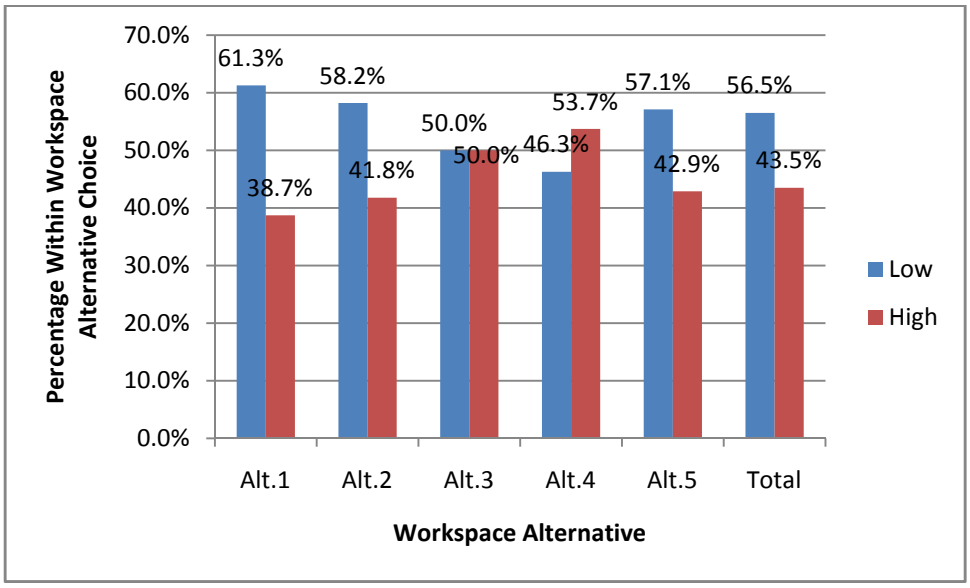


Table 4.36
Workspace Alternative and Physical/Environmental Relative Scores
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.993(a)	4	.407
Likelihood Ratio	3.979	4	.409
Linear-by-Linear Association	1.794	1	.180
N of Valid Cases	363		

Table 4.37
Workspace Alternative and Physical/Environmental Relative Scores Crosstab

			Relative to Median Environmental		Total
			Low	High	Low
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	Count	76	48	124
		% within Workspace Alternative Choice - INDIVIDUAL	61.3%	38.7%	100.0%
		% within Relative to Median Environmental	37.1%	30.4%	34.2%
	Individual Partitioned Space	Count	57	41	98
		% within Workspace Alternative Choice - INDIVIDUAL	58.2%	41.8%	100.0%
		% within Relative to Median Environmental	27.8%	25.9%	27.0%
	Assigend Shared Partitioned Space	Count	29	29	58
		% within Workspace Alternative Choice - INDIVIDUAL	50.0%	50.0%	100.0%
		% within Relative to Median Environmental	14.1%	18.4%	16.0%
	Unassigned Shared Partitioned Space	Count	19	22	41
		% within Workspace Alternative Choice - INDIVIDUAL	46.3%	53.7%	100.0%
		% within Relative to Median Environmental	9.3%	13.9%	11.3%
	Mobile Work Environment	Count	24	18	42
		% within Workspace Alternative Choice - INDIVIDUAL	57.1%	42.9%	100.0%
		% within Relative to Median Environmental	11.7%	11.4%	11.6%
Total		Count	205	158	363
		% within Workspace Alternative Choice - INDIVIDUAL	56.5%	43.5%	100.0%
		% within Relative to Median Environmental	100.0%	100.0%	100.0%

Again, similarity in percentages within the workspace alternative choices for the space factors were an indicator that factor and choice were not associated (figure 4.26). Through crosstabulation of these choices and relative high and low space scores (Table 4.38) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.39) result was .862. This result was higher than .05 which indicated that it can be stated that the score for space factors is not significantly associated with the choices of workspace alternative.

Figure 4.26
Workspace Alternative and Space Relative Scores

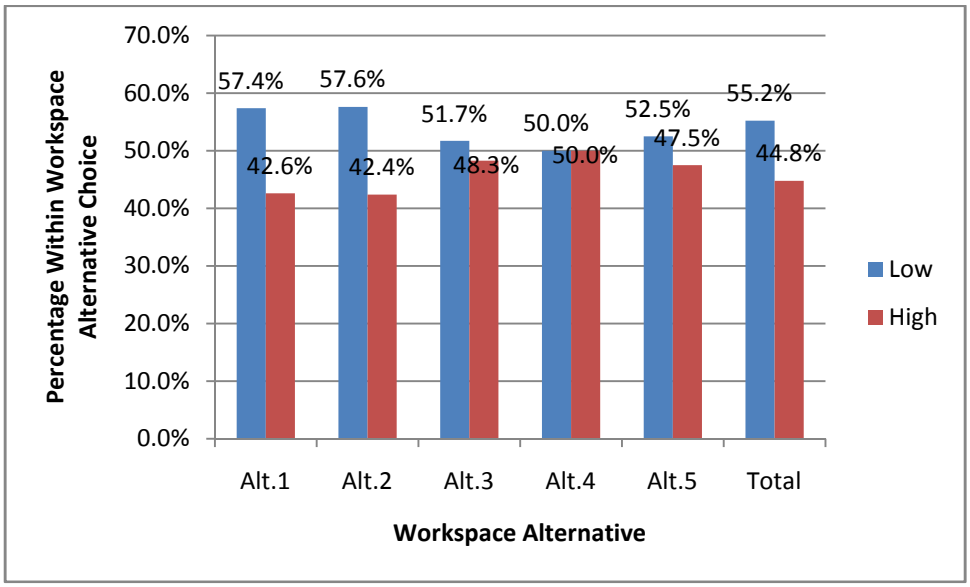


Table 4.38
Workspace Alternative and Space Relative Scores Crosstab

			Relative to Median Space		Total
			Low	High	Low
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	Count	70	52	122
		% within Workspace Alternative Choice - INDIVIDUAL	57.4%	42.6%	100.0%
		% within Relative to Median Space	35.4%	32.3%	34.0%
	Individual Partitioned Space	Count	57	42	99
		% within Workspace Alternative Choice - INDIVIDUAL	57.6%	42.4%	100.0%
		% within Relative to Median Space	28.8%	26.1%	27.6%
	Assigend Shared Partitioned Space	Count	30	28	58
		% within Workspace Alternative Choice - INDIVIDUAL	51.7%	48.3%	100.0%
		% within Relative to Median Space	15.2%	17.4%	16.2%
	Unassigned Shared Partitioned Space	Count	20	20	40
		% within Workspace Alternative Choice - INDIVIDUAL	50.0%	50.0%	100.0%
		% within Relative to Median Space	10.1%	12.4%	11.1%
	Mobile Work Environment	Count	21	19	40
		% within Workspace Alternative Choice - INDIVIDUAL	52.5%	47.5%	100.0%
		% within Relative to Median Space	10.6%	11.8%	11.1%
Total		Count	198	161	359
		% within Workspace Alternative Choice - INDIVIDUAL	55.2%	44.8%	100.0%
		% within Relative to Median Space	100.0%	100.0%	100.0%

Table 4.39
Workspace Alternative and Space Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.298(a)	4	.862
Likelihood Ratio	1.296	4	.862
Linear-by-Linear Association	.897	1	.344
N of Valid Cases	359		

Differences in percentages within the workspace alternative choices for the autonomy factors were an indicator that factor and choice were associated (figure 4.27). Through crosstabulation of these choices and relative high and low autonomy scores (Table 4.41) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.40) result was .050. This result matches the .05 significance which indicated that it can be stated that the score for autonomy factors is significantly associated with the choices of workspace alternative.

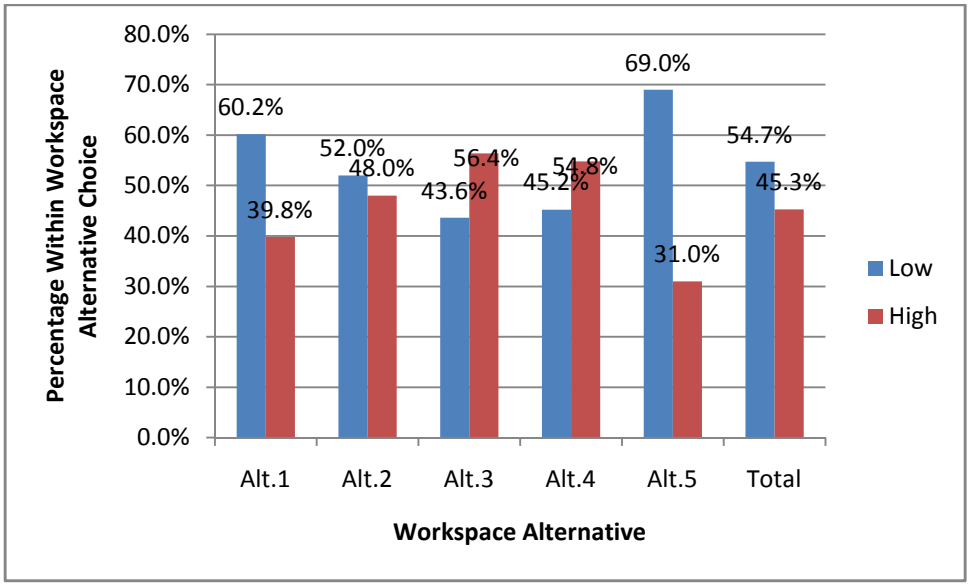
Table 4.40
Workspace Alternative and Autonomy Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.499(a)	4	.050
Likelihood Ratio	9.606	4	.048
Linear-by-Linear Association	.043	1	.836
N of Valid Cases	362		

Table 4.41
Workspace Alternative and Autonomy Relative Scores Crosstab

			Relative to Median Autonomy		Total
			Low	High	Low
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	Count	74	49	123
		% within Workspace Alternative Choice - INDIVIDUAL	60.2%	39.8%	100.0%
		% within Relative to Median Autonomy	37.4%	29.9%	34.0%
	Individual Partitioned Space	Count	52	48	100
		% within Workspace Alternative Choice - INDIVIDUAL	52.0%	48.0%	100.0%
		% within Relative to Median Autonomy	26.3%	29.3%	27.6%
	Assigend Shared Partitioned Space	Count	24	31	55
		% within Workspace Alternative Choice - INDIVIDUAL	43.6%	56.4%	100.0%
		% within Relative to Median Autonomy	12.1%	18.9%	15.2%
	Unassigned Shared Partitioned Space	Count	19	23	42
		% within Workspace Alternative Choice - INDIVIDUAL	45.2%	54.8%	100.0%
		% within Relative to Median Autonomy	9.6%	14.0%	11.6%
	Mobile Work Environment	Count	29	13	42
		% within Workspace Alternative Choice - INDIVIDUAL	69.0%	31.0%	100.0%
		% within Relative to Median Autonomy	14.6%	7.9%	11.6%
Total		Count	198	164	362
		% within Workspace Alternative Choice - INDIVIDUAL	54.7%	45.3%	100.0%
		% within Relative to Median Autonomy	100.0%	100.0%	100.0%

Figure 4.27
Workspace Alternative and Autonomy Relative Scores



Differences in percentages within the workspace alternative choices for the privacy factors were an indicator that factor and choice were associated (figure 4.28). Through crosstabulation of these choices and relative high and low privacy scores (Table 4.42) it was possible to obtain the Pearson's Chi square measure of association. The Pearson's Chi square (Table 4.43) result was .000. This result is less than .05 which indicated that it can be stated that the score for privacy factors is significantly associated with the choices of workspace alternative.

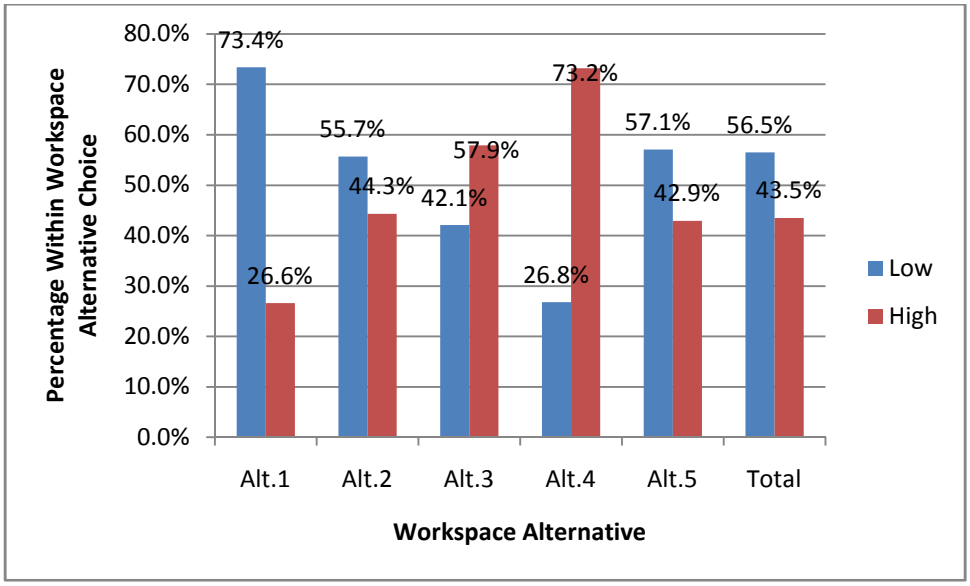
Table 4.42
Workspace Alternative and Privacy Relative Scores Crosstab

			Relative to Median Privacy		Total
			Low	High	Low
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	Count	91	33	124
		% within Workspace Alternative Choice - INDIVIDUAL	73.4%	26.6%	100.0%
		% within Relative to Median Privacy	44.6%	21.0%	34.3%
	Individual Partitioned Space	Count	54	43	97
		% within Workspace Alternative Choice - INDIVIDUAL	55.7%	44.3%	100.0%
		% within Relative to Median Privacy	26.5%	27.4%	26.9%
	Assigend Shared Partitioned Space	Count	24	33	57
		% within Workspace Alternative Choice - INDIVIDUAL	42.1%	57.9%	100.0%
		% within Relative to Median Privacy	11.8%	21.0%	15.8%
	Unassigned Shared Partitioned Space	Count	11	30	41
		% within Workspace Alternative Choice - INDIVIDUAL	26.8%	73.2%	100.0%
		% within Relative to Median Privacy	5.4%	19.1%	11.4%
	Mobile Work Environment	Count	24	18	42
		% within Workspace Alternative Choice - INDIVIDUAL	57.1%	42.9%	100.0%
		% within Relative to Median Privacy	11.8%	11.5%	11.6%
Total		Count	204	157	361
		% within Workspace Alternative Choice - INDIVIDUAL	56.5%	43.5%	100.0%
		% within Relative to Median Privacy	100.0%	100.0%	100.0%

Table 4.43
Workspace Alternative and Privacy Relative Scores Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.915(a)	4	.000
Likelihood Ratio	34.768	4	.000
Linear-by-Linear Association	16.859	1	.000
N of Valid Cases	361		

Figure 4.28
Workspace Alternative and Privacy Relative Scores



4.6.2.3. Preference Scores Analysis Summary

In summary, in the preferences scores analysis section it was possible to identify the preference factors that are associated with choices of workspace type and workspace alternatives made by survey participants.

Workspace type choices were found to be associated with interaction, physical/environmental, and privacy factors (Table 4.44).

Table 4.44
Workspace Type and Factors Association Summary

Factor	Chi square	Significance	Association
Interaction	17.564	0.001	yes
Phisical/Environmental	8.734	0.033	yes
Space	1.214	0.750	no
Autonomy	3.954	0.266	no
Privacy	25.32	0.000	yes

In contrast, workspace alternative choices made by doctoral students were found to be associated with autonomy and privacy (Table 4.45).

Table 4.45
Workspace Alternative and Factors Association Summary

Factor	Chi square	Significance	Association
Interaction	7.841	0.098	no
Phisical/Environmental	3.993	0.407	no
Space	1.298	0.862	no
Autonomy	9.499	0.050	yes
Privacy	33.915	0.000	yes

5. FOCUS GROUPS

5.1. Objective and Sampling

The objective of this study is to identify the possible relationships between stated needs and preferences, and the choices of workspace alternatives and workspace types at any of the three proposed units of analysis (individual, interpersonal, and organizational). These focus groups were designed to obtain qualitative information and test key theories and assumptions of this study. Namely, it concentrates on understanding how workspace choices are influenced by the units of analysis adopted in this study; the constructs of interaction and autonomy; the assumption of distinction between needs and preferences; and the role workspace has on productivity as a general concern of the field.

The key topics addressed in the focus groups were:

1. The impact of needs and preferences on individual workspace choice;

2. The impact of the units of analysis on workspace choice.

3. Perceived necessary levels of interaction for the type of work conducted by participants;

4. Perceived necessary levels of autonomy for the type of work conducted by participants;

5. Physical factors affecting participant's productivity;

A secondary purpose of the focus groups was to address part of the original research questions from a different perspective and assess if there would be differences between the results of the survey and results obtained through qualitative methods. By approaching this study's research questions from a qualitative perspective, it would be possible to either validate results found through the quantitative methods or provide basis for interpreting eventual differences.

Four focus groups were conducted in total. Each focus group had five PhD students participating and lasted between fifty minutes and one hour and twenty minutes. No compensation was offered for participation in the focus groups. A non-probability convenience sample (Kiess, 1996) was used to identify potential participants. The first approach to reach potential participants was through academic advisors of the departments that had manifested interest in the results of the study. As a second approach, students that responded to the survey from different departments were identified as potential contacts. The four focus groups resulted from the second approach. The base criterion for each of the focus groups was that all participants had to work in similar workspace types as defined by Laing and Duffy (1998). Participants were responsive to the questions and engaged by the subject of the discussions.

Group A consisted of five doctoral students from the same department. Their workspace type fit the descriptions of the Cell category. Each individual was assigned to an office that occasionally was shared with one other student. Space was available to them starting at the first semester in the program independent of association with faculty. Four of the

participants were females and one male. Three participants in focus group A were international students.

Group B had five students from two different departments that occupy one building. The workspace type of this group was the Hive. Four to seven students were assigned to one office depending on the time in the program. Space assignment was not associated to research interests or advising faculty. Priority was given to senior students. Two of the participants were females and the remainders were male students. Four of the participants in group B were international students.

Group C had five participants from the same department. The workspace type of this group was the Club. Space assignment was associated to research interests and advising faculty. Use of space was prioritized by consensus based on deadlines and importance to overall research projects conducted by the group. This group had one female student and four male students. Three participants in group C were international students.

Finally, group D had five participants from the same department. This department is housed in two separate buildings. The workspace type of this group was the Den. Space assignment was associated to research interests and advising faculty. Typically, three to six students in the same workgroup shared an office. This group was composed of four females and one male doctoral student. Four of the participants were international students.

5.2. Results

5.2.1. The Impact of Needs and Preferences on Individual Workspace Choice

Focus group participants did understand the semantic differences between the concepts of needs and preferences. The distinction was voluntarily made by participants, and it was evident more in terms of the discussions about equipment and supporting resources than in terms of space. Nevertheless, statements such as “although I would prefer to have an office for my writing, what I have works just fine” illustrated the distinction. In this statement it is implicitly indicated that their acceptance of workspaces that are not in accordance to their preferences is based on the fact that their needs are satisfied by their current workspace arrangements. Similar statements were made by at least one participant in each of the four focus groups conducted. In all cases of such statements other focus group participants would either verbally manifest their agreement or nod their heads up and down signaling agreement with the statement.

On the question about how needs and preferences affected the workspace choices of participants it was not possible to reach a agreement on the matter. Although the majority of participants indicated a willingness to look for a “happy median between what I need and what I prefer” participants made statements supporting choice being guided by needs, and choice being guided by preferences.

Categorical statements such as “I would definitely go with what I prefer” were invariably justified by a productivity statement. Two cases claimed disturbances in their

current workspaces that negatively affected their productivity and felt that if their preferences were met, their productivity would be normalized. A comment that illustrates such positions was “if I could have an office just for me it would be the ideal, I would accomplish much more than I do now.” In the cases of participants that guided their choices by preferences, the aspired workspace alternative was an individual, fully enclosed office.

Participants that had their workspace choices guided by needs justified their position based on financial constraints or budgetary tradeoffs. A statement that illustrated a potential tradeoff was “as long I have the equipments to do my research all the rest is secondary. Sure it would be nice to have an office, but I don’t really need it.” In the cases of financial constraint a claim was that “it is not realistic for me to ask for what I prefer. We have other things that we need to take care of, that HPLC runs on a computer with Windows 98 and it is very slow.”

In either case, participants seemed to have in mind knowledge of budgetary constraints of either their immediate workgroup or department.

5.2.2. The Impact of the Units of Analysis on Workspace Choice

Participants were asked to describe their ideal individual workspaces, as part of their immediate work group, and as part of their organizations. The question left at the discretion of the participants to describe either ideal workspace types or workspace alternatives. All descriptions ended in general levels of space that always could be

categorized in one of the four workspace types described by Laing and Duffy (1998). Independent of the workspace descriptions starting with an individual workspace or with overall adjacencies discussions, consensus on the general workspace type descriptions was reached in all of the focus groups.

Of the descriptions reached in the four groups two were associated with the Club workspace type, one with the Den workspace type, and one with the Cell workspace type. The consensus description of groups A and C description fit the Club workspace type. Their descriptions of ideal workspaces focused on the need for varying levels of interaction and flexibility due to varying workloads over time. Group B reached consensus on the Cell workspace and ultimately agreed on one of the participants' description as "an office just for me that is close to the other students, but an office just for me, and the offices close to the lab." Finally group D described their ideal workspace in terms of spaces that could foster discussion between members of a same workgroup or interested in similar research topics. In this case the Den workspace type best fit this description.

All participants felt that their descriptions of conceptions of ideal individual situations were fair descriptors of the ideal workspaces when considering their interpersonal relations and their organization. Spontaneous justifications for not distinguishing between the units of analysis in cases varied. Yet justifications always implied the consideration of other units of analysis when formulating their description of ideal individual workspace. One statement that illustrated such considerations is "I think that

we would end up with the same. The opinion that I have of what works for me does not necessarily affect my group."

5.2.3. Perceived Necessary Levels of Interaction for the Type of Work Conducted by Participants

Participants were asked to describe the level of interaction required to conduct their work. Levels of interaction described as necessary varied somewhat from group to group and remained constant within the groups. The differences described can be understood as resultant of internal cultural differences between departments and advising faculty teaching style. In groups A and D all participants had different advising faculty. In groups B and C two of the five participating students in each group shared a same advising faculty. Differences between perceptions of necessary levels of interaction and preferred levels of interaction were only manifested by participants in the groups that described needing a low level of interaction.

Groups A and B described a need for very low levels of work related interaction with peer students. In both groups the interactions with peer students were perceived as not necessary yet preferred by some of the individuals and viewed as beneficial by all. The perception of a potential value in having such interaction was present in statement such as "I think it is a plus, but if you don't have it you should be able to conduct your research alone." For group B the allocation of space to students based on time in the program in the hive arrangement can be understood as affecting the relevancy of peer student interaction. One statement that was agreed upon by all participants in this group

was “my officemates work in totally different fields, I mean, so interaction with them will not be that useful to me.” In sum, interaction with peer students was described as casual and not critical to research work in these two groups.

However, participants in both groups indicated pursuing more formal interaction with their respective advising faculty to discuss specific techniques and results. Comments that illustrate these interactions with faculty are: “all these professors are busy and have lots of work to do, so some people just want you to go to them to discuss what the results are”; “if I know they know something that I want to know, then, I schedule a meeting and visit his office.”

Group C worked in a Club environment and agreed on the need for a high degree of interaction with peer student and faculty to conduct their work. The interaction described also happened across groups involved in different research topics. Levels of interaction necessary were described as varying at different stages of different projects, yet overall it was viewed as critical in their processes. The workspace type arrangement was perceived as supporting the stated levels of interaction desired by the group. Some of the agreed comments in this group were: “even if the trial is not for everybody we help each other”; “There is a lot of teaching and learning that goes on (…) we learn from him and whatever we know that we are really good at we will help the other person out.”

Group D also described the need for high degree of interaction with peer students and advising faculty. However, in this group’s case, interactions were limited to individuals

working on similar research topics or specific projects. The interaction at the group level is evident in comments such as “we work always with the same subject so we need to have lots of interaction”; ”and we are working on different projects as well so people work with us from time to time. We have to be talking and meeting with them to decide who is going to do what, and what time, and when can we meet.” Interaction with advising faculty in this group added a different component. All participants reported having daily interactions with advising faculty. However, they also agreed that senior students had different roles in the group and were required to interact more than other students with advising faculty.

5.2.4. Perceived Necessary Levels of Autonomy for the Type of Work Conducted by Participants

Participants were asked to describe the level of autonomy necessary for them to conduct their work. Discussion in all four of the groups focused on two different interpretations of autonomy. The first interpretation considered autonomy in terms of decision making capabilities regarding specific methods and techniques to be used in their research projects. The second type of autonomy discussed was in terms of the autonomy to select research topics when joining the doctoral program.

In the first case there was wide explicit agreement across the focus groups that the level of autonomy varied depending on how long students had been in the program. Participants that were three or more years in the doctoral program would describe having a high level of autonomy. A comment that explicitly expresses this was from group D

"at this point my advisor usually tells me 'I want you to develop this and I want you to get this type of results.' The way I am going to conduct, who I am going to contact, access to a lab, methods, it is up to me." As for comments regarding autonomy for incoming students, the following were the most illustrative: "there is a lot of hand holding that goes on at the first years"; "it is kind of checking if you are moving in the right track, it is always good that somebody guides you, and checks what you are doing at the beginning. It is always good."

In terms of research topic selection three of the focus groups agreed that they had a very low level of autonomy in selecting the topics either due to existing dominant research tracks within the departments, faculty research interests, or external funding. Comments of this nature were "I never have seen the case where the 'big' problem is not given by the professor, 'that will be your problem' you don't have autonomy to choose the topic, inside the topic it is a different matter"; "most of the times we have proposals to follow, the people that are paying are the ones that are ultimately determining what you are going to be doing."

The one group that reported having a high level of autonomy regarding topic choices, mentioned that it was part of the expectations of the doctoral program that applied to all students in their department. An illustration is the comment the set the tone for the discussion with group A and was agreed to by all participants: "You need to be generating your own ideas, and after that initial stage you will have to go at it with

somebody else and they will say you should focus on this or fix this a little bit. You can't be successful in the program if you don't have that."

5.2.5. Revisiting Time in the Program and Identified Factors

Given the result from the focus groups that there are variations on the autonomy levels required by doctoral students over time, it was important to verify if the same can be said from the data in the survey. In order to verify this Spearman correlations tests were conducted between the demographic information about time in the program and the factors identified as associated with workspace choices. Also Kruskall-Wallis comparison statistics (Ott & Longnecker, 2001) were conducted between the factor scores using the time in the program the grouping variable.

It was found that all of the factors associated with workspace choices were not significantly correlated to the time in the program data (table 5.1). Also it was found through the comparisons that there are no significant differences between the factors scores when controlling for time in the program (table 5.2).

Table 5.1
Factors and Time in the Program Correlation

Factor	Correlation Coefficient	Sig. (2-tailed)	N
Interaction	0.038	0.467	365
Physical/Environmental	-0.017	0.745	367
Space	-0.037	0.478	366
Privacy	-0.099	0.059	365

Table 5.2
Factors and Time in the Program Comparison

Factor	Chi-Square	df	Asymp. Sig.
Interaction	2.549	7	.923
Physical/Environmental	3.740	7	.809
Space	8.507	7	.290
Privacy	10.861	7	.145

a Kruskal Wallis Test
b Grouping Variable: Time in the PhD program

As it can be seen from the tables 5.1 and 5.2, the data in the survey does not support the same conclusions regarding variations of autonomy requirements over time in the doctoral program.

5.2.6. Physical Factors Affecting Participant's Productivity

When asked to discuss physical factors that affected participants' productivity there were no particular factors that were indicated as having positive effects on productivity. In contrast there were indications that problems in their existing conditions were hindering their productivity at different levels. Factors that negatively impacted participants' productivity were based in a context of individual preferences and current workspace situation. There was no convergence on specific factors that negatively impacted participants' productivity.

Participants of all groups indicated having experienced some problems or expressed preferences for different solutions than the one available to them at the time. Issues discussed as problematic ranged from problems such as current lighting controls, building location and layout, to adjacencies within departments and support facilities. In

older facilities, problems described tended to be accentuated as in the cases of groups C and D. In group D one comment that illustrates the issue is: “the building is old, so in our office if we have to change the temperature we have to call the physical plant, and then it takes a day, it is crazy that we have to have heaters in our rooms.”

Across all groups there was no agreement as to the extent that these issues truly affected their productivity. Examples of such comments are: “although we are complaining about windows and light, which is a valid point, the fact that we have, even as first year graduate students, an office, we have our own computer, our own desk, our own personal space, I think is an incredible bonus when compared to other places”; “those are all inconveniences, things that I don’t really like but I am not sure how much they really affect my productivity necessarily. I feel that I am a lot more productive close to a deadline anyways.”

5.3. Focus Groups Conclusions

When comparing Laing and Duffy’s interaction and autonomy model of association with workspace types (1998) and the results of the focus groups, it is found that there are clear differences. The fact that Laing and Duffy’s model is static over time does not account for the variability in autonomy over time found in all groups. In terms of interaction levels, two groups, group A and group B, reported having and needing low levels of interaction to conduct their work. The other two groups, group C and group D, reported having and needing high levels of interaction to conduct their work. Current workspace types are aligned with Laing and Duffy’s propositions (Figure 5.1). However,

when comparing workspace type choices made and interaction levels, the choice made by group A the does not fall within Laing and Duffy's model. Table 5.3 displays levels of interactions, choices of workspace type and current spaces per group.

Figure 5.1
Workspace Type Model

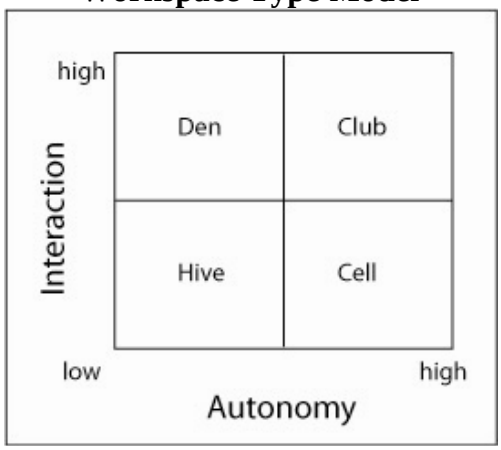


Table 5.3
Interaction and Workspace Types

Group	Level of interaction	Choice of workspace type	Current Workspace type
A	Low interaction	Club	Cell
B	Low interaction	Cell	Hive
C	High interaction	Club	Club
D	High interaction	Den	Den

In the discussion about how the units of analysis adopted in this study influenced choices of workspace type, it was found that participants did not distinguish choices per the units. The concepts and semantic differences between the units of analysis were clearly understood by participants. Nevertheless, when making choices each group seemed to merge the units of analysis in the process. Ultimately the individual workspace choice was the one expressed as the one that guided the participants' decision making process.

In terms of needs and preferences, the majority of participants argued for finding a balance between the two. The semantic distinction between the two concepts was clear and present in the discussions.

Productivity discussions did not identify common factors that had either positive or negative impacts. The findings of the focus groups indicated that although no common factors were found, workspace had the potential to negatively impact participant's productivity.

The focus groups provided relevant findings related to all of the key topics addressed. Agreement was not reached on all subjects, which indicates the potential benefits of further exploring the subject in other focus groups. Findings of the focus groups partially reinforce findings from the statistical analysis, and also provided broader grounds for the discussions and interpretations in the summary and conclusions of this dissertation.

6. SUMMARY AND CONCLUSIONS

The main question of this study was: “What is the relationship between stated preferences, needs, and perceptions about workspace in terms of selected variables, within the choices individuals make when opting for workspace types and workspace alternatives at any of the three proposed units of analysis (individual, interpersonal, and organizational)?” Based on this question three sub questions were posed.

- Are there differences between the choices of workspace types and alternatives made at different units of analysis?

- Do autonomy and interaction, preferences, needs and perceptions influence the choices between workspace types and choices between workspace alternatives?

- Are there variables that influence choices between workspace types and alternatives?

The results of this study shed light onto all of the original research questions, and provide a unique base for the understanding of workspace choices made by individuals.

6.1. Summary of Results

6.1.1. Are There Differences Between the Choices of Workspace Types and Alternatives Made at Different Units of Analysis?

The survey results showed that the choices made by individuals based on the units of analysis used in the study (individual, interpersonal, and organizational) were significantly associated to 95% level of confidence. These results were similar for the workspace type choices and the workspace alternative choices made by survey participants. In other words, it is highly likely that choices will remain the same, when asking individuals to choose between workspace types and between workspace alternatives while considering the units of analysis in each case.

The results of the focus groups on the same topic yielded similar findings. Participants acknowledged the three units of analysis. However, across all focus groups there were no changes to the choices made as an individual when considering the interpersonal or the organizational units of analysis.

6.1.2. Do Autonomy and Interaction, Preferences, Needs and Perceptions Influence the Choices Between Workspace Types and Choices Between Workspace Alternatives?

Factor analysis was conducted to provide a basis to answer the second sub-question in this study. Based on the survey results, this statistical procedure allowed for testing the proposed variable grouping and the determination of relevant factors (Table 6.1).

Responses to each of the three initial sections of the survey yielded the five factors. The variables in each of these factors had common themes and were associated to real world constructs. The five factors identified from the survey results, based on the relevant constructs, were named, interaction, autonomy, privacy, physical/environmental, and space factors.

Table 6.1
Identified Factors & Original Variable Groups

Identified Factor	Variables	Original Variable Group	Changed
Interaction	Team or group work	Interaction	No
	Interaction with coworkers	Interaction	No
	Information exchange with coworkers	Interaction	No
	Interaction with individuals outside immediate workgroup	Autonomy	Yes
	Ability to hold informal meetings	Autonomy	Yes
	Ability to hold private/formal meetings	Autonomy	Yes
Physical/ Environmental	Control over lighting	Physical/Environmental	No
	Control over air quality	Physical/Environmental	No
	Control over ambient temperature	Physical/Environmental	No
	Overall office noise	Physical/Environmental	No
	Overall office comfort	Physical/Environmental	No
Space	Amount of space	Interaction	Yes
	Amount of work surface	Physical/Environmental	Yes
	Amount of work storage	Physical/Environmental	Yes
	Amount of personal storage	Physical/Environmental	Yes
Autonomy	Ability to work remotely	Autonomy	No
	Ability to use paperless processes	Autonomy	No
	Work schedule flexibility	Autonomy	No
	Ability to make decisions about deliverables	Autonomy	No
Privacy	Conversational Privacy	Interaction	Yes
	Visual Privacy	Interaction	Yes

These factors proved to be different from the originally proposed variable grouping of interaction, autonomy and physical/environmental as reflected in Table 6.1. Out of the three initial sections of the survey, it was only in the preferences section that no variables needed to be extracted. The needs section had four out of the twenty one variables extracted. The current workspace section had two of the twenty one variables extracted. See table 6.2.

6.1.2.1. Needs and Preferences

Using the factors identified from the survey results, scores for each of the factors were computed and needs and preferences scores compared. Results indicated with a 95% level of confidence that factor scores for needs and preferences were significantly correlated. Furthermore, correlation coefficients indicated that the correlations found were of a high degree.

To further explore this finding, for all of the twenty one variables selected, needs and preferences correlation levels were evaluated and actual values of pairs the pairs of variables compared. Results of Spearman non-parametric correlations between needs and preferences show that all twenty one variables were positively and significantly correlated. Furthermore, all correlation coefficient indicated a large effect size. Results of the Wilcoxon signed ranks test for these pairs of variables showed that the thirteen of the variables on the needs and preferences sections of the survey had no significant differences with 95% level of confidence. Furthermore, the eight pairs of variables that had significant differences also had effect sizes that are considered small.

Table 6.2
Variables Extracted for Factor Analysis

Factor	Variables	Needs	Preferences	Current
Interaction	Team or group work	**Yes**	No	No
	Interaction with coworkers	No	No	No
	Information exchange with coworkers	**Yes**	No	**Yes**
	Interaction with individuals outside immediate workgroup	**Yes**	No	No
	Ability to hold informal meetings	No	No	No
	Ability to hold private/formal meetings	No	No	No
Physical/ Environmental	Control over lighting	No	No	No
	Control over air quality	No	No	No
	Control over ambient temperature	No	No	No
	Overall office noise	No	No	No
	Overall office comfort	No	No	**No***
Space	Amount of space	No	No	No
	Amount of work surface	No	No	**Yes**
	Amount of work storage	No	No	No
	Amount of personal storage	No	No	No
Autonomy	Ability to work remotely	**Yes**	No	No
	Ability to use paperless processes	No	No	No
	Work schedule flexibility	No	No	No
	Ability to make decisions about deliverables	No	No	No
Privacy	Conversational Privacy	No	No	No
	Visual Privacy	No	No	No

*Cross loaded with Space factors

In the focus groups, participants were asked about how they would balance their needs and preferences when making a workspace choice. A semantic distinction between the concept of needs and the concept of preferences was present in the discussions. However, the majority of participants indicated that a compromise was sought when making their choices of workspace.

6.1.3. Are There Variables That Influence Choices Between Workspace Types and Alternatives?

Given the findings of the survey regarding the units of analysis and the needs and preferences assumption, simplifications in this portion of the statistical analysis were in order. Based on the findings of the survey, a decision was made to study the factors and variables influencing workspace choice only in terms of the choices made considering the individual unit of analysis, and based on the stated preferences of participants.

Through crosstabulation of preference factors and workspace type choices made considering the individual unit of analysis, Chi-square association measures were obtained. The results indicated that workspace type choices were influenced by three of the five factors identified. The factors that influenced workspace type choice were interaction, physical/environmental and privacy. Table 6.3 shows the variables that were identified as significantly loading these factors. Therefore, these variables were also associated with the workspace type choices made.

Similar to the workspace type association measures were obtained for the workspace alternatives. Results indicated that only two factors were identified as associated with the workspace alternatives choices made by survey participants. The factors that influenced workspace alternative choice were autonomy and privacy. Table 6.4 shows the variables that were identified as significantly loading these factors. Therefore, these variables were also associated with the workspace alternative choices made.

Table 6.3
Workspace Type Choice Variables

Factor	Variables
Interaction	Team or group work
	Interaction with coworkers
	Information exchange with coworkers
	Interaction with individuals outside immediate workgroup
	Ability to hold informal meetings
	Ability to hold private/formal meetings
Physical Environmental	Control over lighting
	Control over air quality
	Control over ambient temperature
	Overall office noise
	Overall office comfort
Privacy	Conversational Privacy
	Visual Privacy

Table 6.4
Workspace Alternative Choice Variables

Factor	Variables
Autonomy	Ability to work remotely
	Ability to use paperless processes
	Work schedule flexibility
	Ability to make decisions about deliverables
Privacy	Conversational Privacy
	Visual Privacy

6.1.4. Performance and Productivity

There were no conclusive findings in this study regarding the influence of workspace on either performance or productivity. Based on the survey, no association was found between performance and current individual workspace type or workspace alternative. The focus groups dealing with productivity and findings indicated that while workspace

could hinder productivity, participants did not indicate that workspaces could improve their productivity.

6.2. Results Discussion

The discussions in this portion will be based on the main research question and sub-questions of the study.

The findings of this study indicate that the units of analysis commonly used in workspace studies are not applicable to the study of workspace choices in this population. Similar results regarding the same issue were found through quantitative and qualitative methods. The original hypothesis concerning the units of analysis was that distinctions would be found on two out of the three possible pairs of units of analysis. Namely, differences were expected between individual and interpersonal, and individual and organizational. This proved to be incorrect. In turn this result raises questions as to the validity of using these units of analysis in future workspace choice studies.

The needs and preferences portion of this study produced the most unexpected finding. The semantic distinction between needs and preferences is common in society and explored in architectural practice. The survey results strongly indicated that this population had strikingly similar needs and preferences. Considering the participants' level of education it is hard to argue for the misunderstanding of the concepts or for a lack of a clear semantic differentiation.

From the focus groups it was clear that the difference between the two concepts was well understood. When taking into account the results from the focus groups, where a majority of individuals indicated that their workspace choices were a result of a medium point between needs and preferences, the existence of a distinction is evident. Further evidence of such distinction is the fact that a few of the participants indicated that their choices would be guided only by needs, or only by preferences.

The results from the survey strongly suggest that for surveys with this doctoral student population the semantic distinction between the concepts of needs and preferences is of little consequence. It could be argued that the same balance pursued by a majority of focus group participants is also embedded in the process of responding to separate needs and preferences sections on a survey.

The main question of the study was: “What is the relationship between stated preferences, needs, and perceptions about workspace in terms of selected variables, within the choices individuals make when opting for workspace types and workspace alternatives at any of the three proposed units of analysis?” Given the discussion above, the answer to this question is less complex than originally expected.

In the case of workspace type choices, findings indicate that the individual unit of analysis and stated preferences are the key components of workspace choices made. Furthermore, interaction, physical/environmental, and privacy factors and their

associated preference variables influenced the workspace type choices made by participants of this study.

Study findings also indicate that for the workspace alternative choices, the individual unit of analysis and stated preferences are the key components of workspace choices made by doctoral students. Furthermore, autonomy and privacy factors and their associated preference variables influenced the workspace type choices made by participants of this study.

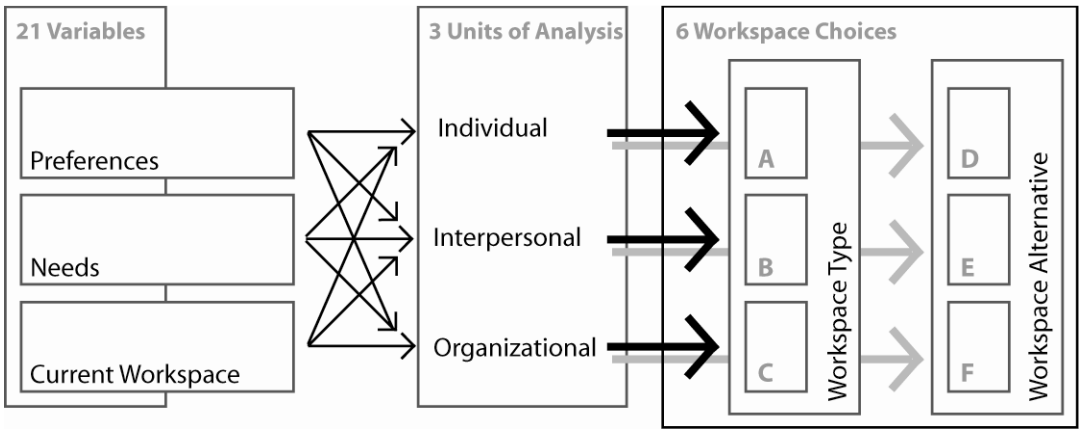
Such findings have direct application in the planning process of new workspaces or the renovation of current workspaces of doctoral students. General workspace type strategies in these cases should focus on the effect of variables associated with preferred levels of interaction, preferences related to physical/environmental factors, and preferred privacy levels. In the case of specific individual workspace alternatives, the variables that must be considered are the ones associated to autonomy and privacy factors. Also, as indicated in the focus groups, since the preferred autonomy levels vary over the course of the doctoral program, thought should be given as to how to accommodate these variations over time.

6.3. Model Development

The model that was tested considered needs, preferences, and current workspace experiences, stated in terms of twenty one variables. It was hoped that it would inform

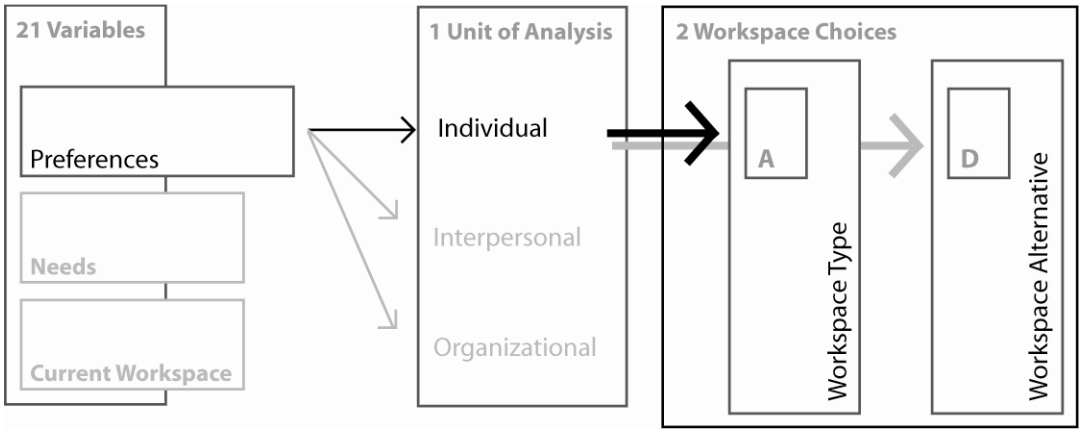
the three units of analysis, and as outcome participants would identify an array of three potential workspace types and three workspace alternative choices (Figure 6.1).

Figure 6.1
Hypothesized Model



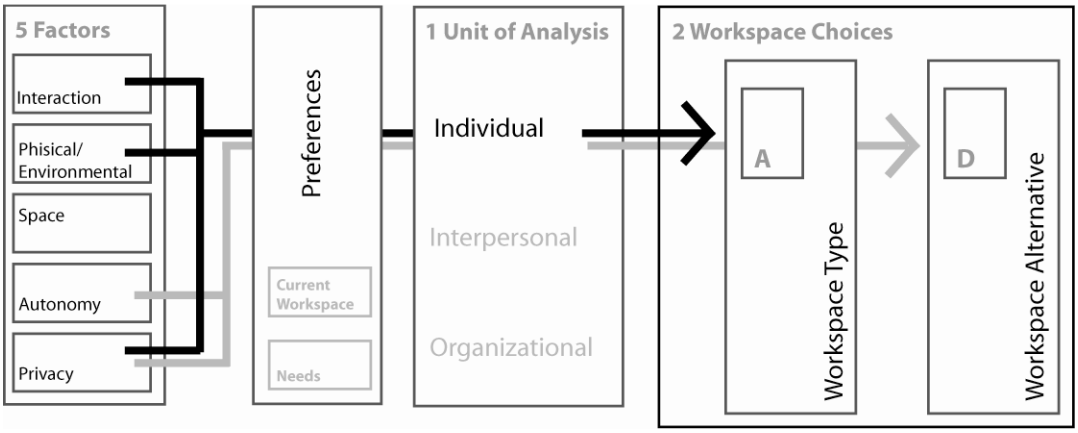
In terms of a model, the findings point to a possible simplification of the originally tested model (Figure 6.2). Results of the study indicated that participants stated preferences in terms of the selected twenty one variables inform the individual unit of analysis which in turn leads to the identification of a preferred workspace type and a preferred workspace alternative.

Figure 6.2
Hypothesized Model Refined by Research Results



The model resulting from the findings from this population shows a different structure. In this new model, preferences stated in terms of the five identified factors, inform the individual unit of analysis which in turn identifies a single workspace type and a single workspace alternative choice. In this revised model it is proposed that needs and current workspace experiences inform the stated preferences, and that the interpersonal and organizational units of analysis inform the individual in the decision making process regarding workspaces (figure 6.3).

Figure 6.3
Revised Model



6.4. Contributions and Originality

As found in the literature review, in past workspace studies little importance was given to the issue of how individuals structured their workspace choices if given the option to do so. A methodology was developed to assess workspace choices. Although this study based its variable selection and part of its questionnaire structure on previous workspace literature, the topic chosen required major adaptations to the original material.

The instrument developed considered two sets of outcomes; one practical and one theoretical. The practical outcome was designed to work as a post occupancy evaluation that could indicate to interested parties actionable points to improve existing workspace conditions. The second outcome responded to the research questions posed in this study by embedding theoretical constructs and assumptions in the structure of the survey so that they could be studied in later stages. The first outcome never materialized as no

particular departments in the university where the study was conducted had an interest in the actual individualized results of the study.

Findings from quantitative and qualitative approaches indicated that well accepted theories and assumptions used in workspace studies do not necessarily apply in the case of studies related to workspace choices among doctoral students. The study also identified, for the population studied, which factors and associated variables influenced the participants' workspace decision making process.

In sum, the study's original contribution to the field is the development of a new research instrument and methodology, as well as results that improve understanding of workspace choices made by individuals.

6.5. Practice Implications

In architectural practice there is a trend towards evidence based design (Hamilton, 2003). The argument is that through the application of research findings in design there is a potential for increasing the positive impacts of environments over its user as well as minimizing the negative one. This approach should be utilized in the workspace planning process.

The application of research based evidence occurs in the architectural programming phase. This phase of the design process is used to inform the designer about the specific requirements of a given architectural project. It is argued here that the formal scholar

research has the potential to be recognized as the pre-programming phase of the design process. In this scenario scholar's research informs the architectural programming phase, by providing relevant project based evidence, which in turn informs the designer.

In the case of the findings of this research, they can be applied in the improvement of the existing doctoral student workspaces in the surveyed institution. Based on the pre-programming evidence provided by this study, workspace planners should give special attention to the factors that were found to be associated to the workspace choices made by doctoral students.

Specifically, when defining the general workspaces that will be used to house doctoral students, each academic unit (department or college) should consider, and define, their requirements in term of interaction, physical/environmental, and privacy factors. In this research these three factors take into account thirteen variables that should be considered in the planning process. In contrast, when the planning process reaches the stage of defining the individual workspaces that will be assigned to each of the doctoral students considerations should shift to the autonomy, and privacy factors, and the six variables that were identified as significantly loading these factors.

6.6. Generalizability and Limitations

The findings of this study are generalizable to the extent of the object population in the study. In other words, findings are generalizable only to the population of full time doctoral students attending the institution surveyed. Although the results indicate

potential conflicts in the applicability of traditional workspace theories and traditional workspace assumptions on workspace choice studies, research with different populations are necessary before making broader generalizations on the topic. Current findings may be used as guidance and benchmarks for future studies a similar topic.

There are three main limitations to this study. One related to organization types, the second related to work types, and finally limitations regarding the selected workspaces in the study.

The research was limited by the limited number and type of organizations willing to participate in the study. Attempts were made to work with elementary schools, as well as energy, telecommunications, and technology organizations. In all cases negotiations subsided due to internal priorities, conflicts, legal constraints, or lack of interest in the subject of the study. Future studies should continue to try to gather data from organizations with two thousand or more potential participants in different market sectors in order to validate or contest the current findings for educational settings.

Another limitation of this study was the departmental structure in the institution where data was collected and the nature of the work conducted by doctoral students. Students from all of the colleges that have a doctoral program participated in the study. Nevertheless, it can be argued that the type of work conducted by the study participants is essentially the same, therefore, limiting the research findings to research work. Similar to the recommendation on the issue of organization types, future studies should focus on

collecting data from different departments. The argument is that in these cases it would be possible to collect data from clearly distinct departments and with defined work type differences between participants. This approach would therefore expand the potential findings and levels of generalization.

Although collecting data from student populations could raise questions about external validity, in this study the questions were related to their needs and preferences regarding workspaces. As already stated the findings are recognized as limited to the extent of the population. In addition to the recognized limitations, doctoral students can be considered a relevant target population for workspace studies.

Although the sample size of this study was adequate for the statistical procedures used it is acknowledged that larger samples would increase statistical power of the results. Similarly more focus groups could provide more evidence for the qualitative portion of future studies.

Finally, in terms of workspace selection limitations, there are no claims as to exhaustion of potential workspace alternatives or workspace types. Selections were made based on relevant literature and existing conditions within the organization studied. Testing the same workspace solutions proposed in this study would allow for expanded generalizations and possible contrasts in findings. Future studies might identify other relevant workspace arrangements, as new technologies and cultural workforce changes modify current understandings and definitions of workspace.

6.7. Future Research

Future research focusing on choice of workspace should continue to attempt to collect data from the private sector. As hard as it has proven to be, there is no doubt in my mind that it is in these organizations where the potential for positive impact of such studies would be the greatest. Such research would expand the findings to other populations and organization types, as well as assist in the planning and development of a new generation of workspaces.

Another potentially beneficial exploration of this topic is the use of logistic regression in the development of a quantitative model of workspace choices. Although this statistical method is already widely used in market preference studies, it has not been explored in the case of workspaces.

Given potential changes in technology, an incoming technologically eager workforce, rising real state costs, global market as a reality, current workspaces can rapidly become partially obsolete, if not totally obsolete. Workspace supply and demand studies, using existing transportation scheduling models, would be crucial to assist organizations coping with changing workspace demands. The use of Building Information Modeling (BIM) as a repository of workspace related data and design memory has to be researched as means of providing faster responses, and potentially to be incorporated in traditional post occupancy evaluations.

Current changes in trends, due to current economic, political, socio-cultural, and physical-temporal contextual pressures, will require a rapid response from organizations, owners, facilities managers, and architects. Capital investments required in traditional approaches of workspace planning and implementation are perceived as prohibitive due to the uncertainties in potential returns on investment. This inhibits the exploration of alternative workspace solutions and even the rectification of known problems in existing work environments.

It is argued here that the risk perception can be drastically reduced by improving the methods to understand and test the impact of innovative workspace solutions. Armed with such information, workspace design/planning teams have the potential to identify best fit scenarios for different organization types, based on their core activities and processes. Capital cost could also be drastically reduced as such methods are improved; immersive virtual spaces are incorporated in the planning process; and new workspace technologies become a reality. In this paradigm, strongly aligned with the principles of evidence based design used in the design of health care facilities, pre-programming continuous research efforts are critical to provide substance to all the parties involved in the processes of workspace planning, design and commissioning.

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APPENDIX A

Figure A1
Web Survey Instrument – Needs Section

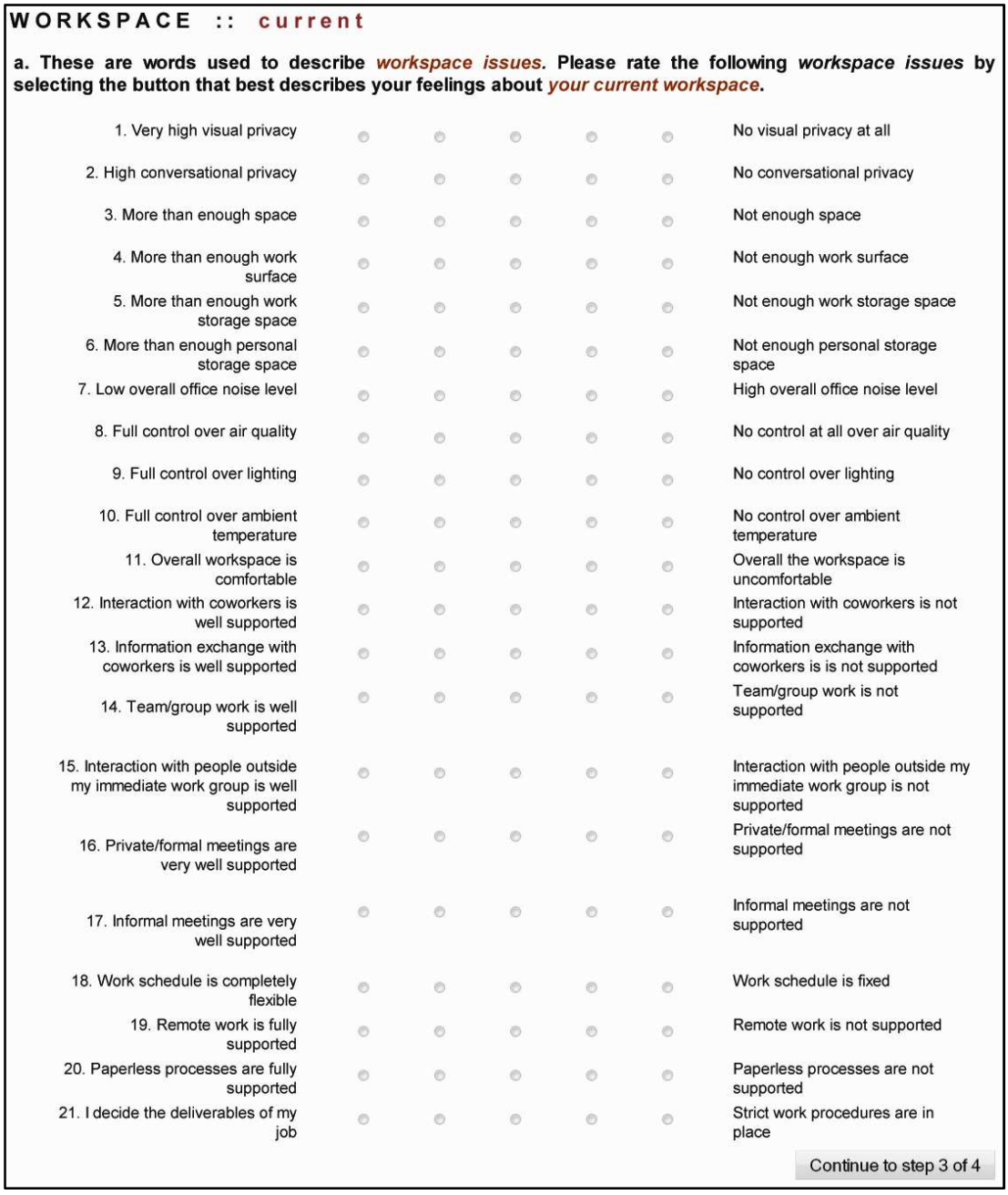
WORKSPACE :: needs

a. Considering the *requirements of your work*, how important would you consider the following *workspace issues* to be?

	Very Important	Slightly Important	Neutral	Slightly Unimportant	Very Unimportant
1.Having visual privacy	○	○	○	○	○
2. Having conversational privacy	○	○	○	○	○
3. Amount of space assigned to you	○	○	○	○	○
4. Amount of work surface assigned to you	○	○	○	○	○
5. Amount of work storage space assigned to you	○	○	○	○	○
6. Amount of personal storage space assigned to you	○	○	○	○	○
7. Low overall office noise	○	○	○	○	○
8. Personal control over air quality	○	○	○	○	○
9. Personal control over lighting	○	○	○	○	○
10. Personal control over ambient temperature	○	○	○	○	○
11. Overall office comfort	○	○	○	○	○
12. Interaction with coworkers	○	○	○	○	○
13. Ability to exchange information with coworkers	○	○	○	○	○
14. Team/group work	○	○	○	○	○
15. Interaction with people outside my immediate work group	○	○	○	○	○
16. Ability to hold private/formal meetings	○	○	○	○	○
17. Ability to hold informal meetings	○	○	○	○	○
18. Work schedule flexibility	○	○	○	○	○
19. Ability to work remotely	○	○	○	○	○
20. Ability to work using paperless processes	○	○	○	○	○
21. Ability to make decisions on deliverables of my job	○	○	○	○	○

Continue to step 2 of 4

Figure A2
Web Survey Instrument – Current Situation Section



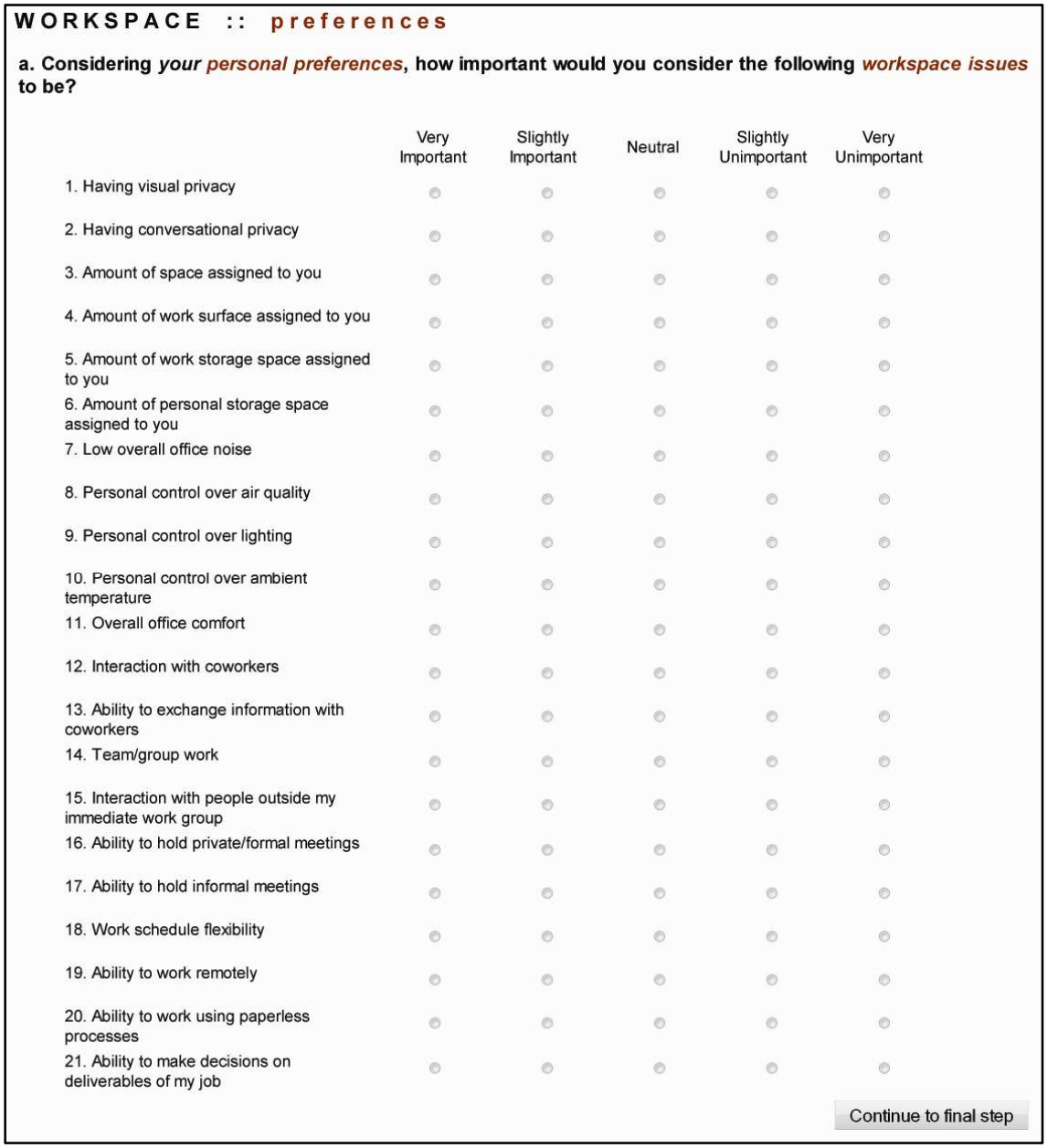
WORKSPACE :: current

a. These are words used to describe *workspace issues*. Please rate the following *workspace issues* by selecting the button that best describes your feelings about *your current workspace*.

1. Very high visual privacy	○	○	○	○	○	No visual privacy at all
2. High conversational privacy	○	○	○	○	○	No conversational privacy
3. More than enough space	○	○	○	○	○	Not enough space
4. More than enough work surface	○	○	○	○	○	Not enough work surface
5. More than enough work storage space	○	○	○	○	○	Not enough work storage space
6. More than enough personal storage space	○	○	○	○	○	Not enough personal storage space
7. Low overall office noise level	○	○	○	○	○	High overall office noise level
8. Full control over air quality	○	○	○	○	○	No control at all over air quality
9. Full control over lighting	○	○	○	○	○	No control over lighting
10. Full control over ambient temperature	○	○	○	○	○	No control over ambient temperature
11. Overall workspace is comfortable	○	○	○	○	○	Overall the workspace is uncomfortable
12. Interaction with coworkers is well supported	○	○	○	○	○	Interaction with coworkers is not supported
13. Information exchange with coworkers is well supported	○	○	○	○	○	Information exchange with coworkers is is not supported
14. Team/group work is well supported	○	○	○	○	○	Team/group work is not supported
15. Interaction with people outside my immediate work group is well supported	○	○	○	○	○	Interaction with people outside my immediate work group is not supported
16. Private/formal meetings are very well supported	○	○	○	○	○	Private/formal meetings are not supported
17. Informal meetings are very well supported	○	○	○	○	○	Informal meetings are not supported
18. Work schedule is completely flexible	○	○	○	○	○	Work schedule is fixed
19. Remote work is fully supported	○	○	○	○	○	Remote work is not supported
20. Paperless processes are fully supported	○	○	○	○	○	Paperless processes are not supported
21. I decide the deliverables of my job	○	○	○	○	○	Strict work procedures are in place

Continue to step 3 of 4

Figure A3
Web Survey Instrument – Preferences Section



WORKSPACE :: preferences

a. Considering *your personal preferences*, how important would you consider the following *workspace issues* to be?

	Very Important	Slightly Important	Neutral	Slightly Unimportant	Very Unimportant
1. Having visual privacy	○	○	○	○	○
2. Having conversational privacy	○	○	○	○	○
3. Amount of space assigned to you	○	○	○	○	○
4. Amount of work surface assigned to you	○	○	○	○	○
5. Amount of work storage space assigned to you	○	○	○	○	○
6. Amount of personal storage space assigned to you	○	○	○	○	○
7. Low overall office noise	○	○	○	○	○
8. Personal control over air quality	○	○	○	○	○
9. Personal control over lighting	○	○	○	○	○
10. Personal control over ambient temperature	○	○	○	○	○
11. Overall office comfort	○	○	○	○	○
12. Interaction with coworkers	○	○	○	○	○
13. Ability to exchange information with coworkers	○	○	○	○	○
14. Team/group work	○	○	○	○	○
15. Interaction with people outside my immediate work group	○	○	○	○	○
16. Ability to hold private/formal meetings	○	○	○	○	○
17. Ability to hold informal meetings	○	○	○	○	○
18. Work schedule flexibility	○	○	○	○	○
19. Ability to work remotely	○	○	○	○	○
20. Ability to work using paperless processes	○	○	○	○	○
21. Ability to make decisions on deliverables of my job	○	○	○	○	○

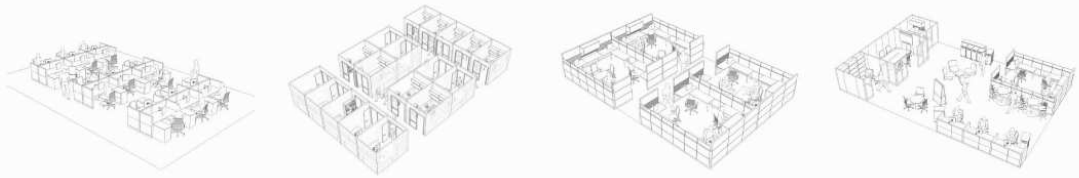
Continue to final step

Figure A4
Web Survey Instrument – Types and Alternatives Section A

WORKSPACE :: types & alternatives

1. The following are *four general workspace types* developed based on work patterns. Please *review the workspace types* descriptions and respond to items a, b, c, and d. *(to view the sample images click on the small images below - to hide the sample images click on Close Image)*

Type 1	Type 2	Type 3	Type 4
Open, ganged (4 or 6 pack), minimal partitions, maximal filing. Imposed simple space standards.	Highly cellular enclosed offices or highly individually used open workstations with high screening or partitions.	Group space or group rooms, medium filling. Complex and continuous spaces, incorporating meeting spaces and workspaces.	Diverse, complex and manipulable range of settings based on high variety of tasks. Space must be zoned and planned to suit diverse use.



	Type 1	Type 2	Type 3	Type 4
a. Which one of these workspace types best describes your current general workspace?	○	○	○	○
b. Given a choice between these workspace types, as an individual, which would you choose?	○	○	○	○
c. Given a choice between these workspace types, considering your immediate workgroup, which would you choose?	○	○	○	○
d. Given a choice between these workspace types, considering your organization, which would you choose?	○	○	○	○

2. How satisfied with your *current* general *workspace type*?

very satisfied	slightly satisfied	neutral	slightly dissatisfied	very dissatisfied
○	○	○	○	○

3. How does your current general *workspace type* affect your *productivity*?

increases my productivity a lot	increases my productivity	no effect	decreases my productivity	decreases my productivity a lot
○	○	○	○	○

4. The following are *individual workspace alternatives* generally used by office workers. Please *review the individual workspace alternatives* descriptions and respond to items *e, f, g, and h*.

Figure A5
Web Survey Instrument – Types and Alternatives Section B

Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Individual Fully Enclosed Space	**Individual Partitioned Space**	**Assigned Shared Partitioned Space**	**Unassigned Shared Partitioned Space**	**Mobile Work Environment**
- Fully enclosed space. - Only one user assigned to the space.	- Enclosed spaces. - Partition height vary to satisfy privacy needs of users. - Only one user assigned to the space. - Can be configured to support group work.	- Partially enclosed spaces. - Partition height vary to satisfy privacy needs of users. - More than one user assigned to the space (based on work schedules). - Can be configured to support group work.	- Level of enclosure and partitioning heights vary. - Configured to support specific tasks. - Space assigned to a defined type of user or to a team. - Use determined by need.	- No specific space assignment. - Work can be done remotely or in the office. - Paperless web processes highly supported. - variety of worksettings available to support individual needs.

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
e. Which one of these workspace alternatives best describes your current individual workspace?	○	○	○	○	○
f. Given a choice between these workspace alternatives, as an individual, which would you choose?	○	○	○	○	○
g. Given a choice between these workspace alternatives, considering your immediate workgroup, which would you choose?	○	○	○	○	○
h. Given a choice between these workspace alternatives, considering your organization, which would you choose?	○	○	○	○	○

5. How *satisfied* are you with the workspace alternative adopted as your *current individual workspace*?

very satisfied	slightly satisfied	neutral	slightly dissatisfied	very dissatisfied
○	○	○	○	○

6. How does your *current individual workspace* affect your *productivity*?

increases my productivity a lot	increases my productivity	no effect	decreases my productivity	decreases my productivity a lot
○	○	○	○	○

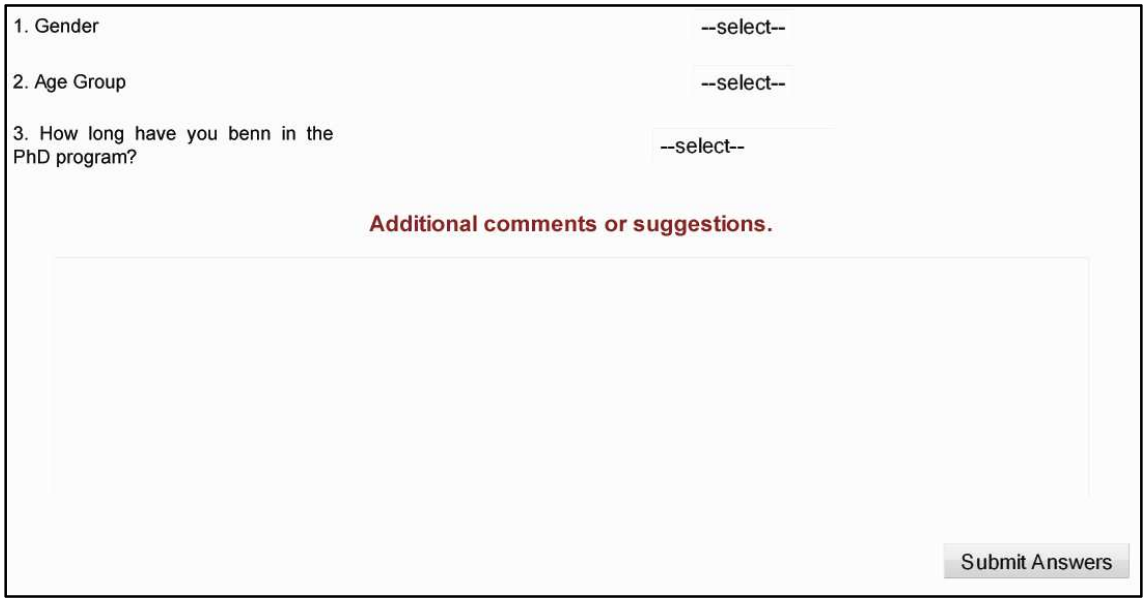
7. How *satisfied* are you with your current *job*?

very satisfied	slightly satisfied	neutral	slightly dissatisfied	very dissatisfied
○	○	○	○	○

DEMOGRAPHIC information

Please provide us with the following *demographic information*.

Figure A6
Web Survey Instrument – Types and Alternatives Section C



APPENDIX B

FOCUS GROUP QUESTIONS

1. Describe you current workspace.

2. How would you describe the level of interaction required to conduct your work?

3. How would you describe the level of autonomy required to conduct your work?

4. Describe how physical attributes of a workspace would affect your productivity.

5. What are the key physical factors of your workspace that affect your productivity?

6. What are other factors that affect your productivity?

7. How would you describe the ideal workspace as an individual?

8. How would you describe the ideal workspace based on your immediate workgroup?

9. How would you describe the ideal workspace based on the organization you work for?

10. How do you describe the effect that your current workspace has on your job satisfaction?

11. When selecting between workspace alternatives how would you weight your individual preferences, needs and current workspace?

12. When selecting between workspace alternatives how would you weight your perspective as an individual, as part of an immediate workgroup and as part of an organization?

APPENDIX C

Table C1
Workspace Type Choice - Organizational * Workspace Type Choice - Interpersonal Crosstabulation

		Workspace Type Choice - INTERPERSONAL				
		Hive	Cell	Den	Club	Total
Workspace Type Choice - ORGANIZATIONAL	Hive	13	3	8	4	28
	Cell	6	79	19	12	116
	Den	2	7	76	5	90
	Club	4	8	18	103	133
Total		25	97	121	124	367

Table C2
Workspace Type Choice - Organizational * Workspace Type Choice - Interpersonal Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	397.922(a)	9	.000
Likelihood Ratio	338.444	9	.000
Linear-by-Linear Association	146.373	1	.000
N of Valid Cases	367		

Table C3
Workspace Type Choice - Individual * Workspace Type Choice - Interpersonal Crosstabulation

		Workspace Type Choice - INTERPERSONAL				
		Hive	Cell	Den	Club	Total
Workspace Type Choice - INDIVIDUAL	Hive	10	1	4	4	19
	Cell	12	86	43	35	176
	Den	1	5	53	7	66
	Club	2	5	23	80	110
Total		25	97	123	126	371

Table C4
Workspace Type Choice - Individual * Workspace Type Choice – Interpersonal Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	256.837(a)	9	.000
Likelihood Ratio	214.572	9	.000
Linear-by-Linear Association	104.718	1	.000
N of Valid Cases	371		

Table C5
Workspace Type Choice - Individual * Workspace Type Choice - Organizational Crosstabulation

		Workspace Type Choice - ORGANIZATIONAL				
		Hive	Cell	Den	Club	Total
Workspace Type Choice - INDIVIDUAL	Hive	11	1	2	5	19
	Cell	12	103	26	35	176
	Den	0	10	43	11	64
	Club	5	2	19	82	108
Total		28	116	90	133	367

Table C6
Workspace Type Choice - Individual * Workspace Type Choice - Organizational Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	273.978(a)	9	.000
Likelihood Ratio	238.758	9	.000
Linear-by-Linear Association	108.578	1	.000
N of Valid Cases	367		

Table C7
Workspace Alternative Choice - Organizational * Workspace Alternative Choice - Interpersonal Crosstabulation

		Workspace Alternative Choice - INTERPERSONAL					
		Individual Fully Enclosed Space	Individual Partitioned Space	Assigend Shared Partitioned Space	Unassigned Shared Partitioned Space	Mobile Work Environment	Total
Workspace Alternative Choice - ORGANIZATIONAL	Individual Fully Enclosed Space	56	18	5	0	3	82
	Individual Partitioned Space	6	85	10	2	0	103
	Assigend Shared Partitioned Space	5	11	70	2	0	88
	Unassigned Shared Partitioned Space	0	3	6	46	0	55
	Mobile Work Environment	1	5	3	5	25	39
Total		68	122	94	55	28	367

Table C8
Workspace Alternative Choice - Organizational * Workspace Alternative Choice - Interpersonal Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	771.298(a)	16	.000
Likelihood Ratio	564.537	16	.000
Linear-by-Linear Association	225.484	1	.000
N of Valid Cases	367		

Table C9
Workspace Alternative Choice - Individual * Workspace Alternative Choice - Interpersonal Crosstabulation

		Workspace Alternative Choice - INTERPERSONAL					
		Individual Fully Enclosed Space	Individual Partitioned Space	Assigend Shared Partitioned Space	Unassigned Shared Partitioned Space	Mobile Work Environment	Total
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	57	40	16	7	3	123
	Individual Partitioned Space	5	68	23	4	1	101
	Assigend Shared Partitioned Space	0	6	49	3	0	58
	Unassigned Shared Partitioned Space	2	1	4	34	1	42
	Mobile Work Environment	3	6	2	7	24	42
Total		67	121	94	55	29	366

Table C10
Workspace Alternative Choice - Individual * Workspace Alternative Choice - Interpersonal Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	525.335(a)	16	.000
Likelihood Ratio	389.124	16	.000
Linear-by-Linear Association	160.249	1	.000
N of Valid Cases	366		

Table C11
Workspace Alternative Choice - Individual * Workspace Alternative Choice - Organizational Crosstabulation

		Workspace Alternative Choice - ORGANIZATIONAL					
		Individual Fully Enclosed Space	Individual Partitioned Space	Assigend Shared Partitioned Space	Unassigned Shared Partitioned Space	Mobile Work Environment	Total
Workspace Alternative Choice - INDIVIDUAL	Individual Fully Enclosed Space	68	30	11	9	6	124
	Individual Partitioned Space	8	66	19	4	4	101
	Assigend Shared Partitioned Space	1	3	46	4	2	56
	Unassigned Shared Partitioned Space	0	0	9	31	2	42
	Mobile Work Environment	5	2	2	7	25	41
Total		82	101	87	55	39	364

Table C12
Workspace Alternative Choice - Individual * Workspace Alternative Choice - Organizational Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	489.883(a)	16	.000
Likelihood Ratio	387.389	16	.000
Linear-by-Linear Association	150.265	1	.000
N of Valid Cases	364		

APPENDIX D

Table D1
Correlation Matrix – Needs 21 Variables

		Visual Privacy - Needs	Conversational Privacy - Needs	Amount of space - Needs	Amount of work surface - Needs	Amount of work storage - Needs	Amount of personal storage - Needs	Overall office noise - Needs	Control over air quality - Needs	Control over lighting - Needs	Control over ambient temperature - Needs	Overall office comfort - Needs	Interaction with coworkers - Needs	Information exchange with coworkers - Needs	Team or group work - Needs	Interaction with individuals outside immediate workgroup - Needs	Ability to hold private/formal meetings - Needs	Ability to hold informal meetings - Needs	Work schedule flexibility - Needs	Ability to work remotely - Needs	Ability to use paperless processes - Needs	Ability to make decisions about deliverables - Needs
Correlation	Visual Privacy - Needs	1.00	0.65	0.15	0.10	0.06	0.08	0.30	0.26	0.28	0.22	0.27	-0.10	-0.08	-0.08	0.00	0.15	0.09	0.10	0.12	0.22	0.19
	Conversational Privacy - Needs	0.65	1.00	0.14	0.15	0.09	0.09	0.34	0.24	0.22	0.20	0.25	0.01	0.01	-0.03	0.06	0.24	0.21	0.11	0.13	0.16	0.14
	Amount of space - Needs	0.15	0.14	1.00	0.54	0.37	0.37	0.15	0.28	0.20	0.20	0.31	0.16	0.21	0.10	0.04	0.15	0.09	0.12	0.03	0.12	0.13
	Amount of work surface - Needs	0.10	0.15	0.54	1.00	0.48	0.25	0.17	0.26	0.22	0.19	0.36	0.13	0.20	0.00	-0.04	0.18	0.19	0.30	0.16	0.11	0.20
	Amount of work storage - Needs	0.06	0.09	0.37	0.48	1.00	0.61	0.21	0.23	0.24	0.15	0.28	0.12	0.21	0.13	0.07	0.23	0.21	0.22	0.18	0.17	0.18
	Amount of personal storage -Needs	0.08	0.09	0.37	0.25	0.61	1.00	0.27	0.30	0.24	0.22	0.30	0.18	0.17	0.20	0.17	0.17	0.13	0.14	0.14	0.14	0.15
	Overall office noise - Needs	0.30	0.34	0.15	0.17	0.21	0.27	1.00	0.44	0.44	0.38	0.34	0.03	0.06	0.02	0.08	0.14	0.12	0.14	0.06	0.15	0.13
	Control over air quality - Needs	0.26	0.24	0.28	0.26	0.23	0.30	0.44	1.00	0.72	0.65	0.49	0.08	0.03	0.05	0.06	0.19	0.13	0.18	0.16	0.24	0.25
	Control over lighting - Needs	0.28	0.22	0.20	0.22	0.24	0.24	0.44	0.72	1.00	0.66	0.55	0.09	0.07	0.03	0.05	0.14	0.12	0.19	0.22	0.22	0.19
	Control over ambient temperature - Needs	0.22	0.20	0.20	0.19	0.15	0.22	0.38	0.65	0.66	1.00	0.53	0.07	0.05	0.02	0.03	0.15	0.08	0.17	0.16	0.15	0.19
	Overall office comfort - Needs	0.27	0.25	0.31	0.36	0.28	0.30	0.34	0.49	0.55	0.53	1.00	0.24	0.16	0.11	0.13	0.20	0.23	0.32	0.21	0.28	0.27
	Interaction with coworkers - Needs	-0.10	0.01	0.16	0.13	0.12	0.18	0.03	0.08	0.09	0.07	0.24	1.00	0.74	0.62	0.53	0.25	0.26	0.14	0.04	0.12	0.15
	Information exchange with coworkers - Needs	-0.08	0.01	0.21	0.20	0.21	0.17	0.06	0.03	0.07	0.05	0.16	0.74	1.00	0.63	0.48	0.27	0.27	0.20	0.03	0.10	0.19
	Team or group work - Needs	-0.08	-0.03	0.10	0.00	0.13	0.20	0.02	0.05	0.03	0.02	0.11	0.62	0.63	1.00	0.62	0.32	0.34	0.14	0.03	0.14	0.23
	Interaction with individuals outside immediate workgroup - Needs	0.00	0.06	0.04	-0.04	0.07	0.17	0.08	0.06	0.05	0.03	0.13	0.53	0.48	0.62	1.00	0.40	0.34	0.12	0.07	0.18	0.20
	Ability to hold private/formal meetings - Needs	0.15	0.24	0.15	0.18	0.23	0.17	0.14	0.19	0.14	0.15	0.20	0.25	0.27	0.32	0.40	1.00	0.69	0.24	0.14	0.20	0.20
	Ability to hold informal meetings - Needs	0.09	0.21	0.09	0.19	0.21	0.13	0.12	0.13	0.12	0.08	0.23	0.26	0.27	0.34	0.34	0.69	1.00	0.30	0.12	0.22	0.20
	Work schedule flexibility - Needs	0.10	0.11	0.12	0.30	0.22	0.14	0.14	0.18	0.19	0.17	0.32	0.14	0.20	0.14	0.12	0.24	0.30	1.00	0.44	0.30	0.37
	Ability to work remotely - Needs	0.12	0.13	0.03	0.16	0.18	0.14	0.06	0.16	0.22	0.16	0.21	0.04	0.03	0.03	0.07	0.14	0.12	0.44	1.00	0.48	0.37
	Ability to use paperless processes - Needs	0.22	0.16	0.12	0.11	0.17	0.14	0.15	0.24	0.22	0.15	0.28	0.12	0.10	0.14	0.18	0.20	0.22	0.30	0.48	1.00	0.40
	Ability to make decisions about deliverables - Needs	0.19	0.14	0.13	0.20	0.18	0.15	0.13	0.25	0.19	0.19	0.27	0.15	0.19	0.23	0.20	0.20	0.20	0.37	0.37	0.40	1.00

Table D1
Correlation Matrix – Needs 21 Variables - Continued

		Visual Privacy - Needs	Conversational Privacy - Needs	Amount of space - Needs	Amount of work surface - Needs	Amount of work storage - Needs	Amount of personal storage - Needs	Overall office noise - Needs	Control over air quality - Needs	Control over lighting – Needs	Control over ambient temperature - Needs	Overall office comfort - Needs	Interaction with coworkers - Needs	Information exchange with coworkers - Needs	Team or group work - Needs	Interaction with individuals outside immediate workgroup - Needs	Ability to hold private/formal meetings - Needs	Ability to hold informal meetings - Needs	Work schedule flexibility - Needs	Ability to work remotely - Needs	Ability to use paperless processes - Needs	Ability to make decisions about deliverables - Needs
Sig. (1-tailed)	Visual Privacy - Needs		0.00	0.00	0.03	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.07	0.49	0.00	0.03	0.02	0.01	0.00	0.00
	Conversational Privacy - Needs	0.00		0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.40	0.42	0.30	0.14	0.00	0.00	0.02	0.01	0.00	0.00
	Amount of space - Needs	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.24	0.00	0.04	0.01	0.29	0.01	0.01
	Amount of work surface - Needs	0.03	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.48	0.20	0.00	0.00	0.00	0.00	0.02	0.00
	Amount of work storage - Needs	0.14	0.05	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of personal storage - Needs	0.07	0.05	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	Overall office noise - Needs	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.25	0.11	0.39	0.06	0.00	0.01	0.00	0.12	0.00	0.01
	Control over air quality - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.07	0.27	0.15	0.14	0.00	0.01	0.00	0.00	0.00	0.00
	Control over lighting - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.04	0.11	0.30	0.17	0.00	0.01	0.00	0.00	0.00	0.00
	Control over ambient temperature - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.09	0.16	0.38	0.29	0.00	0.06	0.00	0.00	0.00	0.00
	Overall office comfort - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Interaction with coworkers - Needs	0.02	0.40	0.00	0.01	0.01	0.00	0.25	0.07	0.04	0.09	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.01	0.00
	Information exchange with coworkers - Needs	0.06	0.42	0.00	0.00	0.00	0.00	0.11	0.27	0.11	0.16	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.25	0.02	0.00
	Team or group work - Needs	0.07	0.30	0.03	0.48	0.00	0.00	0.39	0.15	0.30	0.38	0.02	0.00	0.00		0.00	0.00	0.00	0.00	0.27	0.00	0.00
	Interaction with individuals outside immediate workgroup - Needs	0.49	0.14	0.24	0.20	0.08	0.00	0.06	0.14	0.17	0.29	0.01	0.00	0.00	0.00		0.00	0.00	0.01	0.10	0.00	0.00
	Ability to hold private/formal meetings - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	Ability to hold informal meetings - Needs	0.03	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.01	0.00	0.00
	Work schedule flexibility - Needs	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00		0.00	0.00	0.00
	Ability to work remotely - Needs	0.01	0.01	0.29	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.21	0.25	0.27	0.10	0.00	0.01	0.00		0.00	0.00
	Ability to use paperless processes - Needs	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Ability to make decisions about deliverables - Needs	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

a Determinant = .000

Table D2
Correlation Matrix – Needs 17 Variables

Correlation Matrix(a)

		Visual Privacy - Needs	Conversational Privacy - Needs	Amount of space - Needs	Amount of work surface - Needs	Amount of work storage - Needs	Amount of personal storage - Needs	Overall office noise - Needs	Control over air quality - Needs	Control over lighting - Needs	Control over ambient temperature - Needs	Overall office comfort - Needs	Interaction with coworkers - Needs	Ability to hold private/formal meetings - Needs	Ability to hold informal meetings - Needs	Work schedule flexibility - Needs	Ability to use paperless processes - Needs	Ability to make decisions about deliverables - Needs
Correlation	Visual Privacy - Needs	1.00	0.65	0.15	0.10	0.06	0.08	0.30	0.26	0.28	0.22	0.27	-0.10	0.15	0.09	0.10	0.22	0.19
	Conversational Privacy - Needs	0.65	1.00	0.14	0.15	0.09	0.09	0.34	0.24	0.22	0.20	0.25	0.01	0.24	0.21	0.11	0.16	0.14
	Amount of space - Needs	0.15	0.14	1.00	0.54	0.37	0.37	0.15	0.28	0.20	0.20	0.31	0.16	0.15	0.09	0.12	0.12	0.13
	Amount of work surface - Needs	0.10	0.15	0.54	1.00	0.48	0.25	0.17	0.26	0.22	0.19	0.36	0.13	0.18	0.19	0.30	0.11	0.20
	Amount of work storage - Needs	0.06	0.09	0.37	0.48	1.00	0.61	0.21	0.23	0.24	0.15	0.28	0.12	0.23	0.21	0.22	0.17	0.18
	Amount of personal storage -Needs	0.08	0.09	0.37	0.25	0.61	1.00	0.27	0.30	0.24	0.22	0.30	0.18	0.17	0.13	0.14	0.14	0.15
	Overall office noise - Needs	0.30	0.34	0.15	0.17	0.21	0.27	1.00	0.44	0.44	0.38	0.34	0.03	0.14	0.12	0.14	0.15	0.13
	Control over air quality - Needs	0.26	0.24	0.28	0.26	0.23	0.30	0.44	1.00	0.72	0.65	0.49	0.08	0.19	0.13	0.18	0.24	0.25
	Control over lighting - Needs	0.28	0.22	0.20	0.22	0.24	0.24	0.44	0.72	1.00	0.66	0.55	0.09	0.14	0.12	0.19	0.22	0.19
	Control over ambient temperature - Needs	0.22	0.20	0.20	0.19	0.15	0.22	0.38	0.65	0.66	1.00	0.53	0.07	0.15	0.08	0.17	0.15	0.19
	Overall office comfort - Needs	0.27	0.25	0.31	0.36	0.28	0.30	0.34	0.49	0.55	0.53	1.00	0.24	0.20	0.23	0.32	0.28	0.27
	Interaction with coworkers - Needs	-0.10	0.01	0.16	0.13	0.12	0.18	0.03	0.08	0.09	0.07	0.24	1.00	0.25	0.26	0.14	0.12	0.15
	Ability to hold private/formal meetings - Needs	0.15	0.24	0.15	0.18	0.23	0.17	0.14	0.19	0.14	0.15	0.20	0.25	1.00	0.69	0.24	0.20	0.20
	Ability to hold informal meetings - Needs	0.09	0.21	0.09	0.19	0.21	0.13	0.12	0.13	0.12	0.08	0.23	0.26	0.69	1.00	0.30	0.22	0.20
	Work schedule flexibility - Needs	0.10	0.11	0.12	0.30	0.22	0.14	0.14	0.18	0.19	0.17	0.32	0.14	0.24	0.30	1.00	0.30	0.37
	Ability to use paperless processes - Needs	0.22	0.16	0.12	0.11	0.17	0.14	0.15	0.24	0.22	0.15	0.28	0.12	0.20	0.22	0.30	1.00	0.40
	Ability to make decisions about deliverables - Needs	0.19	0.14	0.13	0.20	0.18	0.15	0.13	0.25	0.19	0.19	0.27	0.15	0.20	0.20	0.37	0.40	1.00

Table D2
Correlation Matrix – Needs 17 Variables - Continued

		Visual Privacy - Needs	Conversational Privacy - Needs	Amount of space - Needs	Amount of work surface - Needs	Amount of work storage - Needs	Amount of personal storage - Needs	Overall office noise - Needs	Control over air quality - Needs	Control over lighting - Needs	Control over ambient temperature - Needs	Overall office comfort - Needs	Interaction with coworkers – Needs	Ability to hold private/formal meetings - Needs	Ability to hold informal meetings - Needs	Work schedule flexibility - Needs	Ability to use paperless processes - Needs	Ability to make decisions about deliverables - Needs
Sig. (1-tailed)	Visual Privacy - Needs		0.00	0.00	0.03	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.02	0.00	0.00
	Conversational Privacy - Needs	0.00		0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00	0.02	0.00	0.00
	Amount of space - Needs	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.01
	Amount of work surface - Needs	0.03	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02	0.00
	Amount of work storage - Needs	0.14	0.05	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	Amount of personal storage -Needs	0.07	0.05	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	Overall office noise - Needs	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.25	0.00	0.01	0.00	0.00	0.01
	Control over air quality - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.07	0.00	0.01	0.00	0.00	0.00
	Control over lighting - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.04	0.00	0.01	0.00	0.00	0.00
	Control over ambient temperature - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.09	0.00	0.06	0.00	0.00	0.00
	Overall office comfort - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
	Interaction with coworkers - Needs	0.02	0.40	0.00	0.01	0.01	0.00	0.25	0.07	0.04	0.09	0.00		0.00	0.00	0.00	0.01	0.00
	Ability to hold private/formal meetings - Needs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	Ability to hold informal meetings - Needs	0.03	0.00	0.04	0.00	0.00	0.01	0.01	0.01	0.01	0.06	0.00	0.00	0.00		0.00	0.00	0.00
	Work schedule flexibility - Needs	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	Ability to use paperless processes - Needs	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00		0.00
	Ability to make decisions about deliverables - Needs	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
A	Determinant = .002																	

Table D3
Correlation Matrix – Preferences 21 Variables

Correlation Matrix(a)

		Visual Privacy - Prefs.	Conversational Privacy - Prefs.	Amount of space - Prefs.	Amount of work surface - Prefs.	Amount of work storage - Prefs.	Amount of personal storage - Prefs.	Overall office noise - Prefs.	Control over air quality - Prefs.	Control over lighting - Prefs.	Control over ambient temperature - Prefs.	Overall office comfort - Prefs.	Interaction with coworkers - Prefs.	Information exchange with coworkers - Prefs.	Team or group work - Prefs.	Interaction with individuals outside immediate workgroup - Prefs.	Ability to hold private/formal meetings - Prefs.	Ability to hold informal meetings - Prefs.	Work schedule flexibility - Prefs.	Ability to work remotely - Prefs.	Ability to use paperless processes - Prefs.	Ability to make decisions about deliverables - Prefs.
Correlation	Visual Privacy - Prefs.	1.00	0.66	0.25	0.21	0.13	0.12	0.33	0.29	0.29	0.26	0.25	-0.01	0.04	-0.03	0.03	0.16	0.12	0.15	0.17	0.16	0.12
	Conversational Privacy - Prefs.	0.66	1.00	0.35	0.26	0.18	0.13	0.36	0.30	0.28	0.32	0.28	-0.02	0.09	-0.02	0.04	0.27	0.25	0.23	0.19	0.16	0.17
	Amount of space - Prefs.	0.25	0.35	1.00	0.70	0.58	0.47	0.17	0.20	0.17	0.17	0.30	0.13	0.18	0.08	0.07	0.12	0.13	0.18	0.16	0.20	0.14
	Amount of work surface - Prefs.	0.21	0.26	0.70	1.00	0.57	0.34	0.15	0.15	0.14	0.10	0.25	0.14	0.20	0.08	0.00	0.07	0.09	0.21	0.13	0.13	0.08
	Amount of work storage - Prefs.	0.13	0.18	0.58	0.57	1.00	0.61	0.26	0.24	0.18	0.17	0.23	0.21	0.21	0.14	0.17	0.20	0.19	0.18	0.18	0.25	0.21
	Amount of personal storage - Prefs.	0.12	0.13	0.47	0.34	0.61	1.00	0.26	0.26	0.17	0.16	0.27	0.17	0.16	0.17	0.20	0.16	0.12	0.10	0.16	0.20	0.21
	Overall office noise - Prefs.	0.33	0.36	0.17	0.15	0.26	0.26	1.00	0.39	0.40	0.34	0.28	0.08	0.09	0.10	0.17	0.15	0.07	0.13	0.17	0.17	0.17
	Control over air quality - Prefs.	0.29	0.30	0.20	0.15	0.24	0.26	0.39	1.00	0.71	0.66	0.38	0.12	0.09	0.11	0.15	0.23	0.13	0.15	0.21	0.30	0.20
	Control over lighting - Prefs.	0.29	0.28	0.17	0.14	0.18	0.17	0.40	0.71	1.00	0.68	0.44	0.07	0.09	0.09	0.16	0.18	0.09	0.21	0.25	0.25	0.27
	Control over ambient temperature - Prefs.	0.26	0.32	0.17	0.10	0.17	0.16	0.34	0.66	0.68	1.00	0.40	0.10	0.14	0.09	0.15	0.18	0.14	0.15	0.21	0.20	0.12
	Overall office comfort - Prefs.	0.25	0.28	0.30	0.25	0.23	0.27	0.28	0.38	0.44	0.40	1.00	0.21	0.23	0.19	0.17	0.20	0.25	0.28	0.31	0.27	0.17
	Interaction with coworkers - Prefs.	-0.01	-0.02	0.13	0.14	0.21	0.17	0.08	0.12	0.07	0.10	0.21	1.00	0.76	0.71	0.55	0.37	0.39	0.16	0.06	0.19	0.19
	Information exchange with coworkers - Prefs.	0.04	0.09	0.18	0.20	0.21	0.16	0.09	0.09	0.09	0.14	0.23	0.76	1.00	0.73	0.54	0.38	0.44	0.19	0.09	0.20	0.20
	Team or group work - Prefs.	-0.03	-0.02	0.08	0.08	0.14	0.17	0.10	0.11	0.09	0.09	0.19	0.71	0.73	1.00	0.65	0.42	0.43	0.11	-0.01	0.15	0.25
	Interaction with individuals outside immediate workgroup - Prefs.	0.03	0.04	0.07	0.00	0.17	0.20	0.17	0.15	0.16	0.15	0.17	0.55	0.54	0.65	1.00	0.49	0.43	0.14	0.07	0.23	0.28
	Ability to hold private/formal meetings - Prefs.	0.16	0.27	0.12	0.07	0.20	0.16	0.15	0.23	0.18	0.18	0.20	0.37	0.38	0.42	0.49	1.00	0.75	0.22	0.15	0.25	0.32
	Ability to hold informal meetings - Prefs.	0.12	0.25	0.13	0.09	0.19	0.12	0.07	0.13	0.09	0.14	0.25	0.39	0.44	0.43	0.43	0.75	1.00	0.29	0.15	0.28	0.33
	Work schedule flexibility - Prefs.	0.15	0.23	0.18	0.21	0.18	0.10	0.13	0.15	0.21	0.15	0.28	0.16	0.19	0.11	0.14	0.22	0.29	1.00	0.45	0.38	0.38
	Ability to work remotely - Prefs.	0.17	0.19	0.16	0.13	0.18	0.16	0.17	0.21	0.25	0.21	0.31	0.06	0.09	-0.01	0.07	0.15	0.15	0.45	1.00	0.57	0.36
	Ability to use paperless processes - Prefs.	0.16	0.16	0.20	0.13	0.25	0.20	0.17	0.30	0.25	0.20	0.27	0.19	0.20	0.15	0.23	0.25	0.28	0.38	0.57	1.00	0.47
	Ability to make decisions about deliverables - Prefs.	0.12	0.17	0.14	0.08	0.21	0.21	0.17	0.20	0.27	0.12	0.17	0.19	0.20	0.25	0.28	0.32	0.33	0.38	0.36	0.47	1.00

Table D3
Correlation Matrix – Preferences 21 Variables – Continued

		Visual Privacy - Prefs.	Conversational Privacy - Prefs.	Amount of space - Prefs.	Amount of work surface - Prefs.	Amount of work storage - Prefs.	Amount of personal storage - Prefs.	Overall office noise - Prefs.	Control over air quality - Prefs.	Control over lighting - Prefs.	Control over ambient temperature - Prefs.	Overall office comfort - Prefs.	Interaction with coworkers - Prefs.	Information exchange with coworkers - Prefs.	Team or group work - Prefs.	Interaction with individuals outside immediate workgroup - Prefs.	Ability to hold private/formal meetings - Prefs.	Ability to hold informal meetings - Prefs.	Work schedule flexibility - Prefs.	Ability to work remotely - Prefs.	Ability to use paperless processes - Prefs.	Ability to make decisions about deliverables - Prefs.
Sig. (1-tailed)	Visual Privacy - Prefs.		0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.39	0.22	0.29	0.30	0.00	0.01	0.00	0.00	0.00	0.01
	Conversational Privacy - Prefs.	0.00		0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.36	0.04	0.38	0.20	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of space - Prefs.	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.09	0.01	0.01	0.00	0.00	0.00	0.00
	Amount of work surface - Prefs.	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.07	0.48	0.10	0.04	0.00	0.01	0.01	0.07
	Amount of work storage - Prefs.	0.01	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of personal storage - Prefs.	0.01	0.01	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00
	Overall office noise - Prefs.	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.07	0.04	0.03	0.00	0.00	0.10	0.01	0.00	0.00	0.00
	Control over air quality - Prefs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.01	0.04	0.02	0.00	0.00	0.01	0.00	0.00	0.00	0.00
	Control over lighting - Prefs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.08	0.04	0.04	0.00	0.00	0.05	0.00	0.00	0.00	0.00
	Control over ambient temperature - Prefs.	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00		0.00	0.03	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Overall office comfort - Prefs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Interaction with coworkers - Prefs.	0.39	0.36	0.00	0.00	0.00	0.00	0.07	0.01	0.08	0.03	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
	Information exchange with coworkers - Prefs.	0.22	0.04	0.00	0.00	0.00	0.00	0.04	0.04	0.04	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	Team or group work - Prefs.	0.29	0.38	0.06	0.07	0.00	0.00	0.03	0.02	0.04	0.04	0.00	0.00	0.00		0.00	0.00	0.00	0.02	0.44	0.00	0.00
	Interaction with individuals outside immediate workgroup - Prefs.	0.30	0.20	0.09	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.08	0.00	0.00
	Ability to hold private/formal meetings - Prefs.	0.00	0.00	0.01	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	Ability to hold informal meetings - Prefs.	0.01	0.00	0.01	0.04	0.00	0.01	0.10	0.01	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	Work schedule flexibility - Prefs.	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00		0.00	0.00	0.00
	Ability to work remotely - Prefs.	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.05	0.44	0.08	0.00	0.00	0.00		0.00	0.00
	Ability to use paperless processes - Prefs.	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Ability to make decisions about deliverables - Prefs.	0.01	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

a Determinant = 3.60E-005

Table D4
Correlation Matrix – Current 21 Variables

Correlation Matrix(a)

		Visual Privacy - Current	Conversational Privacy - Current	Amount of space - Current	Amount of work surface - Current	Amount of work storage - Current	Amount of personal storage - Current	Overall office noise - Current	Control over air quality - Current	Control over lighting - Current	Control over ambient temperature - Current	Overall office comfort - Current	Interaction with coworkers - Current	Information exchange with coworkers Current	Team or group work - Current	Interaction with individuals outside immediate workgroup - Current	Ability to hold private/formal meetings - Current	Ability to hold informal meetings - Current	Work schedule flexibility - Current	Ability to work remotely - Current	Ability to use paperless processes - Current	Ability to make decisions about deliverables - Current
Correlation	Visual Privacy - Current	1.00	0.76	0.42	0.40	0.31	0.32	0.38	0.30	0.39	0.26	0.40	0.06	0.10	0.08	0.13	0.29	0.19	0.15	0.24	0.21	0.22
	Conversational Privacy - Current	0.76	1.00	0.46	0.42	0.33	0.32	0.44	0.39	0.40	0.35	0.42	0.14	0.14	0.15	0.20	0.41	0.32	0.14	0.28	0.25	0.24
	Amount of space - Current	0.42	0.46	1.00	0.85	0.68	0.64	0.42	0.22	0.27	0.21	0.58	0.29	0.30	0.31	0.23	0.41	0.37	0.13	0.23	0.21	0.21
	Amount of work surface - Current	0.40	0.42	0.85	1.00	0.74	0.67	0.36	0.27	0.22	0.27	0.57	0.27	0.28	0.29	0.24	0.40	0.36	0.15	0.27	0.24	0.23
	Amount of work storage - Current	0.31	0.33	0.68	0.74	1.00	0.76	0.34	0.26	0.26	0.22	0.47	0.21	0.22	0.22	0.21	0.32	0.29	0.23	0.21	0.20	0.25
	Amount of personal storage - Current	0.32	0.32	0.64	0.67	0.76	1.00	0.36	0.23	0.27	0.20	0.45	0.26	0.27	0.26	0.22	0.31	0.35	0.22	0.16	0.22	0.19
	Overall office noise - Current	0.38	0.44	0.42	0.36	0.34	0.36	1.00	0.41	0.39	0.36	0.46	0.21	0.23	0.21	0.19	0.33	0.24	0.23	0.27	0.26	0.28
	Control over air quality - Current	0.30	0.39	0.22	0.27	0.26	0.23	0.41	1.00	0.49	0.76	0.41	0.15	0.14	0.16	0.19	0.25	0.17	0.16	0.21	0.21	0.30
	Control over lighting - Current	0.39	0.40	0.27	0.22	0.26	0.27	0.39	0.49	1.00	0.50	0.54	0.23	0.21	0.19	0.18	0.30	0.28	0.16	0.18	0.26	0.30
	Control over ambient temperature - Current	0.26	0.35	0.21	0.27	0.22	0.20	0.36	0.76	0.50	1.00	0.43	0.15	0.16	0.17	0.14	0.28	0.20	0.15	0.20	0.21	0.31
	Overall office comfort - Current	0.40	0.42	0.58	0.57	0.47	0.45	0.46	0.41	0.54	0.43	1.00	0.38	0.34	0.37	0.29	0.40	0.38	0.19	0.24	0.22	0.23
	Interaction with coworkers - Current	0.06	0.14	0.29	0.27	0.21	0.26	0.21	0.15	0.23	0.15	0.38	1.00	0.87	0.78	0.56	0.44	0.58	0.16	0.25	0.30	0.20
	Information exchange with coworkers Current	0.10	0.14	0.30	0.28	0.22	0.27	0.23	0.14	0.21	0.16	0.34	0.87	1.00	0.79	0.58	0.45	0.55	0.18	0.27	0.33	0.18
	Team or group work - Current	0.08	0.15	0.31	0.29	0.22	0.26	0.21	0.16	0.19	0.17	0.37	0.78	0.79	1.00	0.64	0.49	0.56	0.13	0.24	0.31	0.18
	Interaction with individuals outside immediate workgroup - Current	0.13	0.20	0.23	0.24	0.21	0.22	0.19	0.19	0.18	0.14	0.29	0.56	0.58	0.64	1.00	0.55	0.55	0.19	0.27	0.35	0.23
	Ability to hold private/formal meetings - Current	0.29	0.41	0.41	0.40	0.32	0.31	0.33	0.25	0.30	0.28	0.40	0.44	0.45	0.49	0.55	1.00	0.70	0.17	0.35	0.43	0.24
	Ability to hold informal meetings - Current	0.19	0.32	0.37	0.36	0.29	0.35	0.24	0.17	0.28	0.20	0.38	0.58	0.55	0.56	0.55	0.70	1.00	0.20	0.32	0.38	0.20
	Work schedule flexibility - Current	0.15	0.14	0.13	0.15	0.23	0.22	0.23	0.16	0.16	0.15	0.19	0.16	0.18	0.13	0.19	0.17	0.20	1.00	0.49	0.29	0.47
	Ability to work remotely - Current	0.24	0.28	0.23	0.27	0.21	0.16	0.27	0.21	0.18	0.20	0.24	0.25	0.27	0.24	0.27	0.35	0.32	0.49	1.00	0.60	0.47
	Ability to use paperless processes - Current	0.21	0.25	0.21	0.24	0.20	0.22	0.26	0.21	0.26	0.21	0.22	0.30	0.33	0.31	0.35	0.43	0.38	0.29	0.60	1.00	0.45
	Ability to make decisions about deliverables - Current	0.22	0.24	0.21	0.23	0.25	0.19	0.28	0.30	0.30	0.31	0.23	0.20	0.18	0.18	0.23	0.24	0.20	0.47	0.47	0.45	1.00

Table D4
Correlation Matrix – Current 21 Variables - Continued

		Visual Privacy - Current	Conversational Privacy - Current	Amount of space - Current	Amount of work surface - Current	Amount of work storage - Current	Amount of personal storage - Current	Overall office noise - Current	Control over air quality - Current	Control over lighting - Current	Control over ambient temperature - Current	Overall office comfort - Current	Interaction with coworkers - Current	Information exchange with coworkers Current	Team or group work - Current	Interaction with individuals outside immediate workgroup - Current	Ability to hold private/formal meetings - Current	Ability to hold informal meetings - Current	Work schedule flexibility - Current	Ability to work remotely - Current	Ability to use paperless processes - Current	Ability to make decisions about deliverables - Current
Sig. (1-tailed)	Visual Privacy - Current		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.02	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Conversational Privacy - Current	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of space - Current	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	Amount of work surface - Current	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of work storage - Current	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of personal storage - Current	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Overall office noise - Current	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over air quality - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over lighting - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over ambient temperature - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Overall office comfort - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Interaction with coworkers - Current	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Information exchange with coworkers Current	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Team or group work - Current	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.01	0.00	0.00	0.00
	Interaction with individuals outside immediate workgroup - Current	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
	Ability to hold private/formal meetings - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	Ability to hold informal meetings - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	Work schedule flexibility - Current	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00		0.00	0.00	0.00
	Ability to work remotely - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	Ability to use paperless processes - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Ability to make decisions about deliverables - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
a	Determinant = 1.44E-006																					

Table D5
Correlation Matrix – Current 19 Variables

Correlation Matrix(a)		Visual Privacy - Current	Conversational Privacy - Current	Amount of space - Current	Amount of work storage - Current	Amount of personal storage - Current	Overall office noise - Current	Control over air quality - Current	Control over lighting - Current	Control over ambient temperature - Current	Overall office comfort - Current	Interaction with coworkers - Current	Team or group work - Current	Interaction with individuals outside immediate workgroup - Current	Ability to hold private/formal meetings - Current	Ability to hold informal meetings - Current	Work schedule flexibility - Current	Ability to work remotely - Current	Ability to use paperless processes - Current	Ability to make decisions about deliverables - Current
Correlation	Visual Privacy - Current	1.00	0.76	0.42	0.31	0.32	0.38	0.30	0.39	0.26	0.40	0.06	0.08	0.13	0.29	0.19	0.15	0.24	0.21	0.22
	Conversational Privacy - Current	0.76	1.00	0.46	0.33	0.32	0.44	0.39	0.40	0.35	0.42	0.14	0.15	0.20	0.41	0.32	0.14	0.28	0.25	0.24
	Amount of space - Current	0.42	0.46	1.00	0.68	0.64	0.42	0.22	0.27	0.21	0.58	0.29	0.31	0.23	0.41	0.37	0.13	0.23	0.21	0.21
	Amount of work storage - Current	0.31	0.33	0.68	1.00	0.76	0.34	0.26	0.26	0.22	0.47	0.21	0.22	0.21	0.32	0.29	0.23	0.21	0.20	0.25
	Amount of personal storage - Current	0.32	0.32	0.64	0.76	1.00	0.36	0.23	0.27	0.20	0.45	0.26	0.26	0.22	0.31	0.35	0.22	0.16	0.22	0.19
	Overall office noise - Current	0.38	0.44	0.42	0.34	0.36	1.00	0.41	0.39	0.36	0.46	0.21	0.21	0.19	0.33	0.24	0.23	0.27	0.26	0.28
	Control over air quality - Current	0.30	0.39	0.22	0.26	0.23	0.41	1.00	0.49	0.76	0.41	0.15	0.16	0.19	0.25	0.17	0.16	0.21	0.21	0.30
	Control over lighting - Current	0.39	0.40	0.27	0.26	0.27	0.39	0.49	1.00	0.50	0.54	0.23	0.19	0.18	0.30	0.28	0.16	0.18	0.26	0.30
	Control over ambient temperature - Current	0.26	0.35	0.21	0.22	0.20	0.36	0.76	0.50	1.00	0.43	0.15	0.17	0.14	0.28	0.20	0.15	0.20	0.21	0.31
	Overall office comfort - Current	0.40	0.42	0.58	0.47	0.45	0.46	0.41	0.54	0.43	1.00	0.38	0.37	0.29	0.40	0.38	0.19	0.24	0.22	0.23
	Interaction with coworkers - Current	0.06	0.14	0.29	0.21	0.26	0.21	0.15	0.23	0.15	0.38	1.00	0.78	0.56	0.44	0.58	0.16	0.25	0.30	0.20
	Team or group work - Current	0.08	0.15	0.31	0.22	0.26	0.21	0.16	0.19	0.17	0.37	0.78	1.00	0.64	0.49	0.56	0.13	0.24	0.31	0.18
	Interaction with individuals outside immediate workgroup - Current	0.13	0.20	0.23	0.21	0.22	0.19	0.19	0.18	0.14	0.29	0.56	0.64	1.00	0.55	0.55	0.19	0.27	0.35	0.23
	Ability to hold private/formal meetings - Current	0.29	0.41	0.41	0.32	0.31	0.33	0.25	0.30	0.28	0.40	0.44	0.49	0.55	1.00	0.70	0.17	0.35	0.43	0.24
	Ability to hold informal meetings - Current	0.19	0.32	0.37	0.29	0.35	0.24	0.17	0.28	0.20	0.38	0.58	0.56	0.55	0.70	1.00	0.20	0.32	0.38	0.20
	Work schedule flexibility - Current	0.15	0.14	0.13	0.23	0.22	0.23	0.16	0.16	0.15	0.19	0.16	0.13	0.19	0.17	0.20	1.00	0.49	0.29	0.47
	Ability to work remotely - Current	0.24	0.28	0.23	0.21	0.16	0.27	0.21	0.18	0.20	0.24	0.25	0.24	0.27	0.35	0.32	0.49	1.00	0.60	0.47
	Ability to use paperless processes - Current	0.21	0.25	0.21	0.20	0.22	0.26	0.21	0.26	0.21	0.22	0.30	0.31	0.35	0.43	0.38	0.29	0.60	1.00	0.45
	Ability to make decisions about deliverables - Current	0.22	0.24	0.21	0.25	0.19	0.28	0.30	0.30	0.31	0.23	0.20	0.18	0.23	0.24	0.20	0.47	0.47	0.45	1.00

Table D5
Correlation Matrix – Current 19 Variables – Continued

		Visual Privacy - Current	Conversational Privacy - Current	Amount of space - Current	Amount of work storage - Current	Amount of personal storage - Current	Overall office noise - Current	Control over air quality - Current	Control over lighting - Current	Control over ambient temperature - Current	Overall office comfort - Current	Interaction with coworkers - Current	Team or group work - Current	Interaction with individuals outside immediate workgroup - Current	Ability to hold private/formal meetings - Current	Ability to hold informal meetings - Current	Work schedule flexibility - Current	Ability to work remotely - Current	Ability to use paperless processes - Current	Ability to make decisions about deliverables - Current
Sig. (1-tailed)	Visual Privacy - Current		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00
	Conversational Privacy - Current	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of space - Current	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
	Amount of work storage - Current	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Amount of personal storage - Current	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Overall office noise - Current	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over air quality - Current	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over lighting - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Control over ambient temperature - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Overall office comfort - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Interaction with coworkers - Current	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Team or group work - Current	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.01	0.00	0.00	0.00
	Interaction with individuals outside immediate workgroup - Current	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00
	Ability to hold private/formal meetings - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
	Ability to hold informal meetings - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	Work schedule flexibility - Current	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00		0.00	0.00	0.00
	Ability to work remotely - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
	Ability to use paperless processes - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Ability to make decisions about deliverables - Current	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
a	Determinant = 3.46E-005																			

VITA

Name: Carlos Alejandro Nome

Address: Rua Jornalista Lapagesse, 73
Florianópolis, Santa Catarina
Brazil – CEP 88037-240

Email Address: carlosnome@tamu.edu

Education: B.S., Architecture and Urbanism, Federal University of Santa Catarina, Brazil, 1998

M.Eng., Production Engineering, Federal University of Santa Catarina, Brazil, 2002

Ph.D., Architecture, Texas A&M University, 2008